HISTORY

OF

MERCHANT SHIPPING

AND

ANCIENT COMMERCE.

BY

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* The whole of these Illustrations have been re-drawn on block, and a great many of them are original. It is, however, only due to the memory of a truly good and unassuming man to state, more especially as he was a thorough genius in the illustration of all nautical subjects, that many of the drawings are reduced copies from those of the late Edward Weedon, who, for many years, and up to his untimely death in 1874, was one of the staff of artists of the *Illustrated London News*.

MERCHANT SHIPPING.

CHAPTER I.

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MODERN investigation has confirmed the opinion that the knowledge of the ancients was more varied and extensive than has hitherto been generally supposed, and that there is indeed "nothing new under the sun." Iron chain-cables, supposed to have been the invention of the present century, were, as already shown,[1] used by the shipowners of Tyre, while the iron-clad rams of to-day are but copies of the prows of the

Earliest modes of propulsion.

[1] *Ante*, vol. i. Introd. p. xxxi. Arrian, Exped. Alex. II, 21.

war galleys of ancient Carthage, Rome, or Nineveh :[1] and, although, on the sculptures of Egypt and Assyria there is no trace of the application of wheels or machinery of any kind, as a propelling power, the mechanical knowledge ancient inventions exhibit leads to the conviction that other modes of propulsion than those of poles, oars, and sails must have been understood in remote ages. Indeed, Nature herself, at the dawn of knowledge, must have suggested to men widely removed one from the other, appliances for lessening manual labour, while some of these were undoubtedly carried into practice during the earliest period of the existence of the human race.

That such was the case may be reasonably inferred from the ancient stone sculptures exhumed by Layard and others, showing as these do beyond question that the people of Egypt, Assyria and Babylonia, when floating on bundles of reeds or on inflated skins, propelled them by the motion of their legs,[2] just as an animal swims by using its limbs for the purpose of propulsion in the water which supports it. In aquatic animals may be seen the types of almost every kind of machinery now adopted by man to lessen bodily toil. The cuttle-fish moves forward by fins, and backwards by ejecting water from a tube; whelks suggest the art of punting and towing; the value of paddles may be learned from ducks or other aquatic birds in their motion through the water, and the use of a folding feather from the lobster; while the combined action of the

Suggested partly by nature.

[1] Galley from Koyunjik, *ante*, vol. i. p. 276.

[2] See the bas-reliefs from Nineveh, British Museum.

paddle-wheel and screw-propeller will be found in the microscopic insects "Paramacium caudatum" and "Paramacium compressum." The marine animals "Vebella" and "Physalia," familiarly known as the "Portuguese men-of-war," whose bodies resemble an inflated bladder, float on the water and are propelled by the wind acting on their extended membranes. Swans extend their feathers to sail with the wind; and, though that fairy-looking, fragile thing, the paper-nautilus, seems to be the sport alike of the gale and of the most gentle breeze, it possesses in itself the power of propulsion by projecting water.[1]

But the common fish of every sea would have suggested to man, in the most remote ages, a mode of supplementing manual labour: the fin giving him

[1] Owen's "Lectures on Comparative Anatomy," 2nd. ed. p. 605. Carpenter's "Physiology," 645. "Woodcroft on Marine Propulsion," note, p. 1, and drawing of Nautilus in frontispiece to Woodcroft's "Steam Navigation." See also an interesting paper, read at the Society of Arts on the 14th of April, 1858, by John MacGregor, Esq., M.A., Barrister at Law.

the idea of a paddle or of an oar, and the tail teaching him the art of sculling, the principle in each case being the same: the tail, moving from side to side, by oblique pressure on the water, propels the fish forward along a diagonal line, the resultant of the forces acting from the right and the left sides of the fish, and is, thus, the chief instrument of motion, while the fins serve to direct and steady it.[1]

Hero of Alexandria, B.C. 120.

Nor, indeed, is there much doubt that the ancients were acquainted with the power of steam, though they cannot be said to have applied this knowledge to any useful purposes. A treatise is still in existence "On Pneumatics," by Hero,[2] a philosophic mathematician who lived at Alexandria about B.C. 120, in which he gives an account of seventy-eight miscellaneous experiments, most of them probably adapted for the superstitious purposes of the heathen priesthood, but some also as certainly foreshadowing the definite application of steam as a

[1] There is little difference between the action of an oar in sculling and that of the modern screw-propeller, which is fast superseding the paddle-wheel in all ocean-going steamers: the one has an alternate lateral motion, like the tail of a fish; the other is rotatory, but with the same effect. It may be added that fishes often have the power of "feathering" their tails, by puckering their lobes in their forward motion, and expanding them on their return, so as to displace as little water as possible, while they, at the same time, rely for their advancement on the reaction of the water in the direction of their body. These points have been carefully considered in the construction and arrangement of the blades of the screw, as well as the important fact that the tail of the fish or the sweep of an oar in their motions displace a quantity of water, great in proportion to the length of the instruments employed; and further, that it is by the resistance the water makes to this displacement by the oar or tail, in their continued oscillation, coming as these do from their extreme sweep to the axis of the boat or fish, that either is urged forward.

[2] An edition of Hero's "Pneumatics" has been published by Mr. Woodcroft. Lond., 4th ed. 1851. His second experiment is referred to in Muirhead's "Life of James Watt," 2nd ed. p. 107.

motive force. The following, we notice as, in themselves, of considerable interest.

"First," he says (exper. No. 45), "let there be a cauldron with water in it and a covered top; and let a fire be lighted under it. From the cover let a tube Dancing steam ball. run upward, and place at its extremity a hollow hemisphere, in like manner perforated. Then, if a light ball be cast into the middle of the hemisphere, the vapour (steam) raised from the cauldron through this tube will lift the ball so that it seems suspended."

This is no doubt an ingenious and amusing philosophical toy, but has no further value. His next experiment, however (No. 50), is of greater importance, not only as showing a clear and distinct appreciation of the motive power of steam, but because its principle is embodied in the well-known mode of driving potters' wheels and in the modern turbine. He says, "Let a fire be lighted under a cauldron with water Æolipile. in it and covered with a lid; and attach to this cauldron a bent tube with the extremity fitting into a hollow ball. Opposite to the extremity of this

tube place a pivot fastened to the lid, and let the ball have various tubes communicating with it at opposite ends of the diameter, with their bendings at right angles (i.e., in opposite directions). Then when the fire is lighted, the steam passing through the first tube (i.e., from the cauldron) into the ball, will pass out through the bent tubes towards the lid, causing the ball to revolve after the fashion of dancing figures."[1] This machine was called the Æolipile.

[1] The principle of Hero's steam-machine depends on the physical law that, when any fluid issues from a vessel in which it has been confined, the vessel is acted on by a force equal to that with which the fluid escapes, but in the opposite direction. Thus, if water issues from an orifice, a pressure is produced behind the orifice corresponding to the force with which the water escapes: hence, the recoil of a gun when fired. If the muzzle were turned at right angles to the length of the gun, the explosive gases would escape sideways, and the shooter, instead of being forced back, would spin round. The orifices in each case are exposed to the atmosphere, which tends to rush in with a force of a little less than 15 lbs. on the square inch: the force, therefore, with which the steam escapes represents the excess of its elasticity over that of the atmosphere, which furnishes, as it were, the fulcrum, and thus

In these few words we have a clear indication of the power of steam, of the nature and effect of a vacuum, and of a rotatory engine moved by this force: we thus see that the ancients knew more than has been generally admitted of the wonderful power which, in our own time, has brought about the most extraordinary changes in the seats and centres of maritime commerce, affording to mankind a facility of intercourse between different nations, while at the same time increasing the wealth, and, what is of much more importance, promoting the comfort and happiness of the human race to an extent far beyond the dreams of the most sanguine enthusiast of any age or of any country.

From the uncontroverted facts here stated, there can be no doubt that Hero was the first to record, even if he did not invent, this mighty civilising instrument, and, if so, that Egypt was the land of its birth.

Application of science to superstitious purposes.

But many centuries elapsed before its power was applied to any useful purpose; indeed, as suggested, there is reason for supposing that this science was misapplied by the priests, and used as a means of deceiving the people by inducing them to believe it to be a miraculous power granted only to the professors of the craft of idolatry. "A fire," says Hero (experiment No. 70), "having been kindled on a transparent altar, figures will appear to dance"

gives motion to the machine. Mr. Bourne states that the principle of the Æolipile is the same as that embodied in Avery and Ruthven's engines for the production of rotatory power. "These engines," he says, "are more expensive in steam than ordinary engines and travel at an inconvenient speed; but in other respects they are quite as effectual, and their construction is extremely simple and inexpensive."

on a drum driven round by steam, "emitting sounds similar to those of a stringed instrument,"[1] which, according to Pausanias, "resemble the snapping of the strings of a harp;" thus, while delighting the young people of those days, as the ornaments in churches now do, these experiments became instruments of make-belief in the hands of the priests, who propounded as strange theories about their supernatural powers as the so-called philosophers of our own days still do, when they attempt to deal with the unrevealed mysteries of creation and of a still more mysterious hereafter.[2]

[1] In another experiment (No. 37), Hero shows "how temple doors may be opened by fire on an altar." He says, "Let the proposed temple stand on a pedestal, on which is also a small altar. Through the altar insert a tube, of which one mouth is within the altar, and the other nearly at the centre of a globe. The tube must be soldered to the globe in which a bent syphon is placed. Let the hinges of the doors be extended downwards, turning freely on pivots, and from the hinges let two chains running into one be attached by means of a pulley to a leaden weight, on the descent of which the doors will be shut, let the outer leg of the syphon bend into a suspended vessel and fill the globe half full of water. When the fire becomes hot, the heated air in the altar expands and, passing through the tube into the globe, will drive the liquid through the syphon into the suspended vessel which, descending by its weight, will tighten the chains and open the doors."

[2] Although there may be a doubt how far the inventions recorded by Hero were used for superstitious practices, there is no question that, somewhat later, the agency of steam was employed for purposes anything but legitimate. Thus Gibbon (c. xl.) gives an amusing account of how Anthemius, the architect of Sta. Sophia at Constantinople, avenged himself on Zeno, the orator. "In a lower room," says he, "Anthemius arranged several vessels or cauldrons of water, each of them covered by the wide bottom of a leathern tube, which rose to a narrow top, and was artificially conveyed among the joints and rafters of the adjacent building. A fire was kindled beneath the cauldron; the steam of the boiling water ascended through the tubes; the house was shaken by the effects of imprisoned air, and its trembling inhabitants might wonder that the city was unconscious of the earthquake they had felt." Still later, Arago, in his "Éloge de James Watt," notices an ancient Teutonic god, called *Bustarich*, on the banks of the Weser,

Although the Romans did nothing towards applying the knowledge of the power of steam to useful purposes, and little enough generally for the mechanical arts, the true value of the works of Hero and of the older mechanicians came to be appreciated in the dawn which succeeded the darkness of the Middle Ages. Then the youths of a generation, which had cast aside many of the superstitions of the ancients, and had found in the doctrines of Christianity a wider and nobler field for their genius and aspirations, began to study how the power Hero had described could be best applied for the benefit and happiness of mankind. Then, indeed, was the advent of an era wherein the foundation was laid of a fabric which, though slow in its erection, and not yet completed, is destined to eclipse all the other works of man. There can be, therefore, no subject affecting the transitory interests of the human race more worthy of the pen of the historian than the development of the power and usefulness of steam traced from that remote period to our own time, when we see in every quarter of the civilised world this power compassing land and ocean, affording profitable employment to myriads of the human race, and giving to the people of every nation and tongue rapid and easy intercourse.

Revival of learning.

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who was made by the priests to show his displeasure through the agency of steam. The head of the metal God was hollow and had within it a pot of water. Its mouth and another hole having been plugged, a charcoal fire was cleverly lighted under it, in such a way as not to be perceived by the expectant worshippers. After a while, the imprisoned steam forced out the plugs, with a loud report, followed by two jets of steam, which formed a dense cloud round the god and concealed him from his astonished worshippers.

"Although an old work on China," remarks Mr. MacGregor,[1] "contains a sketch of a vessel moved by four paddle-wheels, and used perhaps in the seventh century, the earliest distinct notice of this means of propulsion appears to be by Robertus Valturius in A.D. 1472, who gives several woodcuts representing paddle-wheels,"[2] one of which is as follows.

Robertus Valturius, 1472.

There is, however, no mention of any vessel propelled by *steam* till M. de Navarette directed attention to this subject in a letter[3] received by him from Thomas Gonzales, Director of the Royal Archives of Simancas of Spain, with an account of an experiment of the year 1543, in which a vessel is said to have been propelled by something resembling a steam-engine.

The substancė of this letter is to the effect that, in that year, one Blasco de Garay, proposed to the Emperor Charles V., the construction of an engine (*ingenio*) capable of propelling large vessels in a calm, and without the use of sails or oars. In spite of the

[1] Paper read at the Society of Arts 14th of April, 1858, by John MacGregor, Esq., Barrister at Law.

[2] This work in Latin, printed at Verona, 1472, is the first book with woodcuts printed in Italy.

[3] This letter is written from Simancas, and bears date 27th August, 1825. It was published 1826, in Lack's "Astronomical Correspondence."

opposition this project encountered, the Emperor consented to witness the experiment, which was accordingly made in the *Trinity*, a vessel of 200 tons, laden with corn, in the port of Barcelona, on the 17th June, 1543. Garay, however, would not uncover his machinery, or exhibit it publicly: but it was evident that it consisted of a cauldron of boiling water (*una gran caldera de agua hirviendo*) and of two wheels set in motion by that means, and applied externally on each side (*banda*) of the vessel.

Blasco de Garay, story of his experiment, 1543.

The persons commissioned by the Emperor to report on the invention seem to have approved it, commending specially the readiness with which the vessel tacked. The treasurer Ravago, however, observed that a ship with the proposed machinery could not go faster than two leagues in three hours; that the apparatus was complex and expensive; and that there was danger of the boiler bursting. The other commissioners maintained that such a vessel might go at the rate of a league an hour, and would tack in half the time required by an ordinary ship. When the exhibition was over, Garay removed the apparatus from the *Trinity*, depositing the wood-work in the arsenal at Barcelona, but retaining himself the rest of the machinery. Notwithstanding, however, the objections urged by Ravago, the Emperor was inclined to favour his project, but his attention at the time was engrossed by other matters.[1] Garay was, however, promoted and received a sum of money, besides the expenses of the experiment made at

[1] The interview with the Pope took place at Bupeto, 22nd of June, 1543, and the campaign against the duke of Cleves, the ally and general of Francis, followed.

Barcelona. The letter concludes with the following statement:—

"This is the substance of the despatches and of the original registers preserved in the royal archives of Simancas, among the State papers of the province of Catalonia, and of those of the Secretary of War (department of land and sea), in the said year, 1543."

Mr. MacGregor, greatly to his credit, desirous of ascertaining whether this report (which, from the well-known accuracy of M. de Navarette on other subjects, had been accepted as correct) could be depended upon, visited Spain in September, 1857, and made a thorough investigation at Simancas, Madrid, and Barcelona into this interesting subject, but his inquiries (reported, at length, January, 1858, to the Superintendent of Specifications at the Great Seal Patent Office, and printed in Part II., "Specifications relating to Marine Propulsion"), convinced him "that there was not one particle of reliable evidence" in M. de Navarette's assertion.[1]

[1] "On the 23rd of September last (1857)," remarks Mr. MacGregor, "I visited the town of Simancas, near Valladolid in Spain, with Captain John Ussher, to inspect some letters of Blasco de Garay, which are there preserved among the national archives.

"Having obtained the requisite Royal permission, I was allowed, after much difficulty, to read (but not to copy) two letters signed by Blasco de Garay, written clearly in Spanish and well preserved. One of these was addressed from Malaga, the other from Barcelona; and both were dated, A.D. 1543. They describe two separate experiments with different vessels, both of them moved *by paddle-wheels turned by men.*

"One vessel was stated to be of two hundred Spanish tons burthen, propelled by a paddle-wheel on each side, worked by twenty-five men. The other vessel was moved in a similar manner by forty men (in all). The speed attained is mentioned in the text, and is stated in a side note (written in a different hand) to have been one league, about three and a half English miles per hour. Various calculations, as to the tonnage, the motive power, the cost, and other matters are contained

An attentive consideration of the subject leads to the conclusion at which Mr. MacGregor has arrived. Even in the present day it would require an engine

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in the letters, and it is said that the vessel thus moved was found to steer well, but could be propelled more easily for a long time by oars. Also that, like other inventions, this would probably be improved by the experience of further trials. We read the letters carefully through, and neither of them contained any mention whatever of the use of steam, or any expression to indicate that this was contemplated.

"The officer left in charge of the documents, Don Manuel Garcia, said that he did not know of any other letters of Blasco de Garay, or of any other authentic papers relating to his experiment; that he believed most certainly Blasco de Garay did not invent or suggest the use of steam for propulsion; and that the assertion he had made was '*un mensonge historique.*'"

Disproved by Mr. MacGregor's investigations.

On October 15th, 1857, and following days, Mr. MacGregor made diligent inquiries at Barcelona respecting Blasco de Garay, and after writing a letter inviting information on the subject to the *Diario de Barcelona*, 19th October, 1857, Señor Michel Mayor undertook to satisfy his inquiries. In the Archives of Aragon, the Director said that no trace of any document relating to Blasco de Garay was to be found, and, that the MSS. in that library were only by order of reigns, and not by dates. With the assistance of Don Gregorio and Fidil Clares, Mr. MacGregor states that he inspected the catalogue of the Bibliotheca Publica and of the Bibliotheca Publica Episcopal without any better result, the keepers of these libraries declaring they knew nothing of any other letter of Blasco de Garay; one of these officers said he believed that men only had been used to move the vessel, and the Government Inspector of Mines assured him that he was of the same opinion. But a Spanish engineer mentioned that some of the actual *steam-engine machinery* used in the vessels was still to be seen at the School of Artillery; after, however, diligent inquiry there, Mr. MacGregor could find no trace of any of these relics.

But after these investigations, it was reported to Mr. MacGregor through Colonel Stopford, of Madrid, that there was another letter of Blasco de Garay, in which he alludes to the steam-boat, and that this document was kept secret at Madrid, which, as Mr. MacGregor adds, "would not probably be the case if by its means the claim of a Spaniard to the invention of the steam-boat could be substantiated;" and he remarks in conclusion that, *if* Blasco de Garay used a steam-engine to propel a vessel, the evidence of this fact is not supported by his two letters at Simancas, and, further, that it has not been produced, if it is known there or at Barcelona, by the public officers and others interested in supporting such a claim.

and boiler of considerable size to propel a vessel of 200 tons three miles an hour; moreover, the novel and bulky machinery with which the experiment is said to have been made, could not have been erected in the ship or removed from her without attracting considerable public attention. Indeed, had such an experiment been made before the Spanish Emperor, and made successfully as the narrative leads us to suppose, a matter so important could hardly have lain dormant for any great length of time: whatever, therefore, Blasco de Garay's invention may have been, it was evidently not a steam-engine practically applicable for any useful purpose.

Witzen, no doubt, in confirmation of Garay's experiment, furnishes an illustration of a "Spanish bark without oars or sails," but as, unfortunately, there is not a single line of letter-press beyond the few words quoted to throw the faintest light upon his drawing, it can only be supposed from the descriptive title that it referred to the vessel which Garay is said to have propelled. Indeed, De Garay's whole story looks very much as if it was an invention of the Spaniards; Mr. Scott Russell,[1] as well as Mr. MacGregor, is of this opinion, and Mr. Woodcroft, no mean authority on such matters, states that, having made diligent inquiries at Simancas, he could find no trace of these documents, thus confirming the result of the more minute researches of Mr. MacGregor.[2]

[1] "Steam and Steam Navigation;" and article, "Steam Navigation," *Encyclopædia Britannica*, 8th ed., vol. xx. p. 636.

[2] Since Mr. MacGregor's visit, M. Bergenroth, who has done so much towards the elucidation of the manuscript treasures at Simancas, has been able at his leisure to copy the documents relating to De Garay, preserved there, they are;—1. A holograph from him to the Emperor,

About this period, however, frequent mention is made of other modes of propulsion besides those hitherto in use. J. C. Scaliger (who died 1558) published at Frankfort a short notice of a vessel to be propelled without oars. Bourne, in 1578,[1] says, in his own quaint style, "you may make a boate to goe without oares or sayle by the placing of certain wheeles on the outside of the boat in that sort that the armes of the wheeles may go into the water, and so turning the wheeles by some provision, and so the wheeles shall make the boate goe." I. Bessoni, in 1582, describes a vessel with two prows, or rather two separate vessels attached to each other (not unlike the *Castalia*, now running between Dover and Calais), between which a frame is suspended on gimbles carrying at its lower end a circular reel worked by ropes and a winch whereby they can be propelled.[2] A. Ramelli, in 1588, furnishes a design of a flat-bottomed boat with a wheel on each side, turned by men working upon a winch handle.[3] Indeed, long before this, the celebrated Roger Bacon (A.D. 1214–1296) speaks of a "vessel which, being almost

Progress of invention; Bourne, Solomon de Caus, Marquess of Worcester, &c.

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dated Malaga, September 10th, 1540, containing his report on the trial of one of his paddle-wheel ships. 2. The report of Captain Antonio Dastigasura on the same trial trip. 3. The report of the Proveedores of Malaga concerning the same trip, dated July 24th, 1540. 4. The report of Blasco de Garay to the Emperor, dated July 6th, 1543, concerning the trial trip of another of his paddle-wheel ships, made at Barcelona in June, 1543. 5. A letter of Blasco de Garay to Carrs, dated June 20th, 1543. In none of these is any reference to steam-power to be found—thus completely confirming Mr. MacGregor's previous statements.

[1] "Inventions and Devises," by William Bourne, p. 15; London, 1578.

[2] Woodcroft's "Manuscript Collection" and "Marine Propulsion," vol. i. p. 7.

[3] "Marine Propulsion" from Patent Office, Woodcroft, vol. i. p. 8.

wholly submerged, would run through the water against waves and winds with a speed greater than that attained by the fastest London pinnaces."[1] Baptista Porta (the inventor of the magic lantern) published in his "Pneumaticorum Libri Tres," Naples, 1601, many curious experiments on the power of steam, on its condensation, and on its relative bulk as compared with water. In one of these a vacuum is clearly indicated, the water being forced up by the pressure of the atmosphere from without.

David Rivault, Seigneur de Flurance near Laval, published "Les Éléments de l'Artillerie," first in 1605 and secondly in 1668—and in this work he describes the power of steam in bursting a strong bomb-shell partly filled with water, tightly plugged, and then heated.

In 1615, Solomon de Caus (Engineer to Louis XIII.) published a treatise ("Les Raisons des Forces Mouvantes") in which he shows he was well acquainted with the motive power of steam—as, in his fifth theorem, he says, "water will mount by the help of fire higher than its level:" he also shows, by an experiment, how a column of water may be driven up a tube to such a height as will balance the elasticity of the heated air confined in the boiler; and Arago, in his "Éloge de James Watt," considers that this experiment, though of little practical use, "will make a noble figure in the annals of the steam-engine."

In 1629, Giovanni Branca, an engineer of Loretto, applied steam to blow against vanes attached to the external rim of a wheel, and, doubtless, machinery with due mechanical contrivances could have been

[1] Works of Roger Bacon, Hamburg, ed. 1598, pp. 74–75.

impelled by it. He gives a picture of his machine in "Le Machine," vol. nuovo, Pl. xxv.

In 1618, David Ramsay obtained a patent for an invention "to make boates for carriages running upon the water as swift in calmes and more safe in storms than boats full sayled in great windes;" and in 1630 he patented a plan "to make boats, ships, and barges to goe against the wind and tide;" and "to raise water from lowe pitts by fire"[1] (the steam-engine).

In 1637, Francis Lin and others patented a plan "to use and exercise upon the River Thames, and any other river within England and Wales, according to their owne way and inventing the sole drauinge and workinge up of all Barges and other vessels without the use of horses;" and, in 1646, Edward Ford proposed a similar plan for the navigation of rivers, and one whereby he could "bring little ships, barges, and vessels in and out of havens without or against any small wynd or tide, and transport souldiers and passengers without or against wynde yf the seas be not rough."[2]

In 1652 (July 30th), Thomas Grant, Doctor of Physic, obtained a patent "for several instruments, whereof the first is an instrument very profitable when coñon winds fayle for a more speedy passage of calmed shipps or other vessells upon the sea or great rivers, which may be called the wynds mãty."

In the recital of the inventions of the Marquess of Worcester, 8th February, 1661, reference is made to one which was "applicable to make a boat that roweth or letteth, even against wind and stream to any part of the compass which way soever the streame runs or wind blows, and yet the force of the wind or stream causeth its motion." But though

[1] "Woodcroft on Steam Navigation," pp. 3 and 4. [2] Ibid., p. 5.

the Marquess has generally had the credit of having applied a power other than manual or animal labour for the purpose of propulsion, it has been doubted from the description of his invention if it was a steam-engine which could be applied to drive a boat.[1]

Petty, in 1663, used a double boat with success.[2] Chamberlaine and Bushnell, in 1678, had also their plans for propelling boats against wind and tide, while Hooke, in 1661, described windmills in which "we have all the main features both of the screw-propeller and feathering wheel."[3]

Morisotus' *vessel* with *paddle-wheels.*

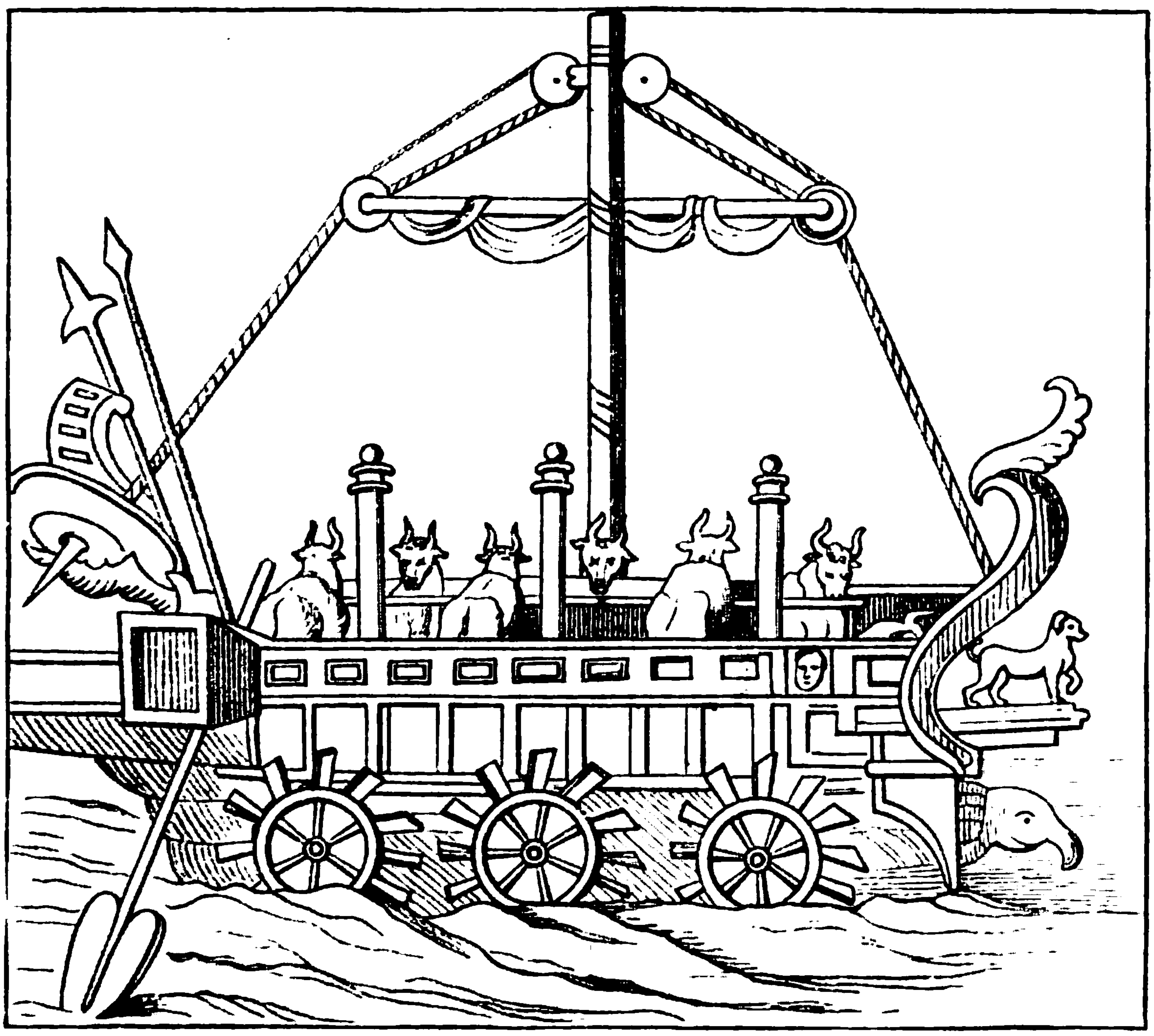
From about this period much attention was

[1] Although there is no evidence that the Marquess of Worcester did employ steam to propel any boat, it must be allowed (in spite of the perhaps natural desire of Mr. Muirhead to exalt the genius of his relative, James Watt) that he was the first to make an actual steam-engine. Certain important points are clear from his description, viz., that the vessel in which the water was evaporated was distinct from that containing the water to be raised; that there were two vessels of similar description, the contents of which were alternately raised by the pressure of the "water rarefied by fire;" and that the water was lifted in a continuous stream by the aid of two cocks communicating with these vessels, and with the boiler. Now this is exactly the agency of steam at the present time, in that it is generated in one vessel, and used for mechanical purposes in another: indeed, it is just this distinction which shows the invention to have been a true one—for had the action of the steam been confined to the vessel in which it was produced, it would have been of no more practical use than were the experiments of Hero, De Caus, or Rivault. Complaint has been often made of the indistinctness and incompleteness of the descriptions furnished by the Marquess in his famous "Scantlings of one hundred Inventions," but it may be doubted whether the author's intention was really to convey knowledge of the mechanism he used, or even to indicate the physical principles on which they depend. His statement, however, is sufficient to enable any one possessing a knowledge of the mechanical qualities of steam, to understand the general nature of the machine produced. It ought also to be remembered that many of the ideas of inventions thrown out by the Marquess, as stenography, speaking statues, combination locks, &c., &c., have been since his time carried into effect.

[2] "Buchanan on Steam Propelling," Glasgow, 1816, p. 161.

[3] "Bourne on the Screw-Propeller," pp. 5 and 9.

directed to the use of machinery for propulsion. Morisotus, moreover, who published his views in 1643,[1] speaks of the paddle-wheel as a mode of propelling vessels, known also, as he believed, to the ancients, and states that the simple machinery employed was the same in fact as was in his day used in mining operations in the Spanish Indies. Schefer, in his



instructive and interesting work, also makes mention of a remarkable vessel described by Pancirolli (who wrote, in 1587, on naval and military matters) as resembling what he had seen in an old bas-relief of an Illyrian galley, a vessel apparently propelled by wheels similar in character to those in the above wood-cut, from Morisotus.

[1] Morisotus, "Orbis Maritima," Generalis Historia divisio, fol., 1643.

But, as no such clumsy vessel could have been employed in a seaway, her movements must have been confined to rivers or inland waters. It is just possible that such and similar vessels might at some period have been used for ferrying rivers[1] or lakes. Very extraordinary notions, however, appear to have been propounded about, and subsequently to, this period, and, as a matter of curiosity, I furnish one of these

Hollar's drawing.

taken from Hollar's engravings, which does not appear to have been noticed by any writer on this interesting subject. The original engraving, bearing date A.D, 1653, is to be found in the British Museum. Various details[2] are furnished by the inventor.

Besides the detailed explanation of this extraordi-

[1] The ferry boats at Quebec plying between the opposite sides of the river St. Lawrence were, at a very recent period, if they are not so still, propelled by horses and oxen walking along circular platforms so as to produce a power applied to the paddle-wheels of the boat. And a boat of a somewhat similar kind was, in the course of the present century, employed for some time between Yarmouth and Norwich in this country.

[2] 1. The middle beam. 2. The end with iron bars wherein the strength of the ship lyeth both ends alike. 3. Rudder of the ship. 4. The keel. 5. Iron bolts with screws. 6. Depth of the inner beam. 7. The wheel that goeth round it hath its motion. 8. The scuttles or hatchways. 9. The gallery where they walk.

nary looking craft, which in "length is 72 feet, the height 12, the breadth 8," there is beneath the print the following description: "The true and perfect form of the strange ship built in Rotterdam, 1653. The inventor of it doth undertake in one day to destroy a hundred ships, it can go from London to Rotterdam and back again in one day, and in six weeks to go to the East Indies, and to run as fast as a bird can fly. No fire, nor storme, nor bullets can hinder her unless it please God. Although the ships mean to be safe in their havens, it is in vain, for she shall come to them in any place. It is impossible for her to be taken unless by treachery, and she cannot be governed by any one but himself" (the inventor?). The motive power is not described, and there is no further trace of the ship, of which the illustration is a vertical section. She was built at the time when the Dutch were in the zenith of their power, and most likely proved as worthless as numerous other inventions since produced, though curious as showing the attention devoted at this period to wheels as a mode of propelling vessels.

However, we find in the records of our own Patent Office, that Englishmen were not behind the Dutch in curious and frequently very absurd inventions. Thus, in 1675, one Miller[1] patented a windmill fixed to a vessel's deck to turn an endless rope, and thus, by "two toothed wheels," to drive a couple of paddle-wheels. Such commonplace matters as storms at sea or adverse winds, still less the likelihood of the whole of the top weight he pro-

Absurd patents.

[1] "Specifications relating to Marine Propulsion," Woodcroft, Part I. p. 29.

posed to erect on the deck of his vessels being blown or rolled overboard, do not appear to have entered into the fertile and imaginative brain of the inventor.

Again, in 1701, two gentlemen (whose names are not worth recording) proposed to have "vanes or sails arranged between two wheels on the same shaft," the "sails or float-boards being so contrived as to be able to play in a given space, being fixed perpendicularly on the wheel and fastened by a cord or otherwise, so that when the wind blows from any quarter three-fourths of the sails catch the wind, and, by driving the wheel round, the sails, which are forced against the wind, come up edgeways, but when past the centre immediately turn to the breeze, and by that means produce a continued circular motion."[1]

About the same period another invention, of a somewhat similar sort, was published by a person named Phillips, who proposed to erect between two tall masts "a windmill of altogether an original description."[2] One is reminded when reading these grave proposals, of Don Quixote's ludicrous exploit with the windmill, and considering the care Mr. Phillips seems to have bestowed upon his invention, he must have been quite as enthusiastic

Phillips and his windmill.

[1] Woodcroft, Part I. p. 51; and see Drawings, "Repository of Arts," vol. i. (second series), p. 11.

[2] "He was a foolish man," says Dr. Arnott, "who thought he had found the means of commanding always a fair wind for his pleasure boat by erecting an immense bellows in the stern. The bellows and the sails acted against each other, and there was no motion: indeed, in a perfect calm, there would be a little backward motion, because the sail would not catch all the wind from the bellows."—Arnott, "Elements of Physics," p. 120.

and apparently as serious in his proposal as the hero of Cervantes in his knight-errantry. But all these schemes, and many others too numerous to mention, however impracticable and absurd some of them may have been, had the germ of the great invention more or less developed.

Papin and Morland

During Papin's residence in England, 1681, he witnessed one of the interesting experiments made on the Thames, in which a boat constructed from the design of the Prince Palatine Robert, fitted with revolving oars or paddles, "left the King's barge, manned by sixteen rowers, far astern in the race of trial." This experiment suggested to him, in 1688, the idea of an engine, and led to his proposal of using gunpowder to create a vacuum under a piston, so that the piston would descend. Two years afterwards, 1690,[1] Papin describes a steam cylinder, in which a piston descends by atmospheric pressure when the steam below it is condensed, and among the subsequent uses of such a machine he mentions the propulsion of ships by "Rames volatiles" or paddle-wheels, the axles of which, he thought, might be turned by several of his cylinders acting alternately by the rack work shown in his drawing.[2]

[1] "Specifications of Marine Propulsion," Woodcroft, vol. i. pp. 16 and 17.

[2] Papin was driven from France by the revocation of the Edict of Nantes, and was associated with Robert Boyle in many of his experiments on the air-pump—he was elected F.R.S. in 1681, and was for a time, the secretary of the society. He was invited to Germany by the Landgrave of Hesse, was some years Professor of Mathematics at Marburg and died there, 1710; he seems the first to have clearly discerned the necessity of the vacuum under the cylinder, and that the pressure of the atmosphere alone is enormous. (A cylinder 1 foot in diameter, has a surface of 113 square inches, hence, the atmospheric

In 1683, a little before Papin, Sir Samuel Morland, Master of Works to Charles II., wrote a treatise on the "Élévation des Eaux par toutes sortes de Machines," &c., with four pages appended to it called "The Principles of the New Force of Fire, invented by Samuel Morland in 1682, and presented to His Most Christian Majesty in 1683." In this work (still in MS. in the Harleian Collection of the British Museum), it is stated that "water being converted into vapour by the force of fire, these vapours shall require a greater space (about 2000 times) than the water occupied, and sooner than be constantly confined would split a piece of cannon." It is remarkable that, so long before careful experiments had been made on the expansibility of water when converted into vapour, Morland should have given so near an approximation to the true amount (about 1750 times).

Savery. Thomas Savery, one of the most ingenious men of the age in which he lived, proposed (1696) a mode of raising water and occasioning motion "to all sorts of mill-work by the impelling force of *Fire*,"

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pressure in it is 113 × 15 = 1695 lbs.). Papin first proposed to exhaust the air by pumps, and in 1687 laid this plan before the Royal Society; but such a plan would only have been a transference of power, the effect being the same in character as that of lifting the water to the water-wheel. His most important invention was that of a method of producing a vacuum by the condensation of steam—the reversal, in fact, of the process of the previous machines of De Caus and Lord Worcester. He drew the inference that, if water in its conversion into steam swelled many hundred times, it must follow that steam reconverted into water would shrink into its primitive dimensions. He was also the first to suggest the safety-valve, but he did not, strange to say, apply it to the machine subsequently invented. It has been asserted, though not proved, by some writers that Papin derived many of his ideas from Otto von Guericke, who had invented an air-pump as early as 1654.

adding,[1] "it may be very useful to ships, but I dare not meddle with that matter, and leave it to the judgement of those who are the best judges of maritime affairs."[2]

In 1697, Papin (whose own invention had proved a failure) used Savery's engine, which had been greatly improved by Newcomen in 1705 to propel a *steam-boat* on the Fulda.[3] In that year, too, Papin proposed to drive a vessel by paddle-wheels turned by the stream, and by boat-hooks which somehow pushed against or griped the bottom.[4] Chabert, in 1710, described a vessel with large paddle-wheels working in troughs cut through the hull;[5] and, in 1721, we read of a galley built in France with revolving oars fastened to a drum or wheel with paddle-vanes on hinges, capable of being set to any angle, and of being worked by 200 men,

[1] The "Miners' Friend," &c. A paper published by Savery in 1702.

[2] Thomas Savery was born about 1650, and, in early life, served as a military engineer; he then gave himself to the study of mechanics, and constructed a clock still in existence. He also made a boat with paddle-wheels, turned by a capstan, his object being, as he says, to enable ships to be moved independently of the wind. He next invented what he called his "Fire-machine," and exhibited it to William III. and the Royal Society in 1699. He applied his engine largely to the pumping out of mines, and, though it was found ultimately to have too little power, and was superseded by that of Newcomen, Savery may fairly claim the credit of having constructed the first really practicable steam-engine. He invented also a very ingenious plan for determining the height of the water in the boiler of the steam-engine, which is still sometimes used.

[3] Letters to Leibnitz, "Dictionnaire des Inventions," Migne's N. Encycl., Paris, 1852, vol. xxxvi., art. "Vélocipèdes," p. 317. Thomas Newcomen was a working blacksmith in the town of Dartmouth (Devon). He was assisted in his inventions by John Calley, a glazier of the same place, with whom he subsequently entered into partnership, and erected more than one engine which successfully pumped water from mines.

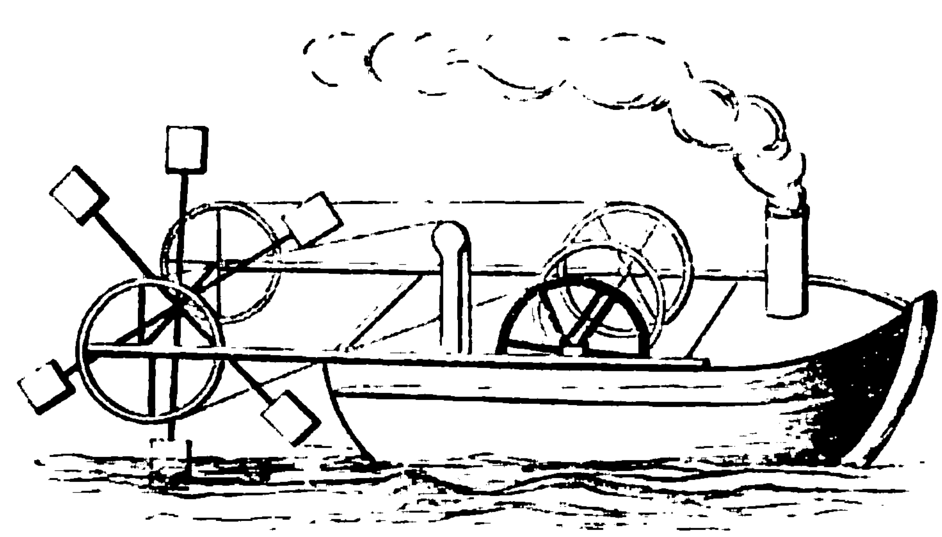
[4] "Acta Eruditorum," 1737, p. 80.

[5] Ibid., 1709, p. 282.

the galley having three of these wheels on each side.[1] John Allan, in 1722, proposed a mode of navigating a ship, "by forcing water or some other fluid through the stern or hinder part, at a convenient distance under the surface of the water, into the sea, by proper engines placed within the ship." He also proposed, as Papin had previously done, a machine with the power of "firing gunpowder *in clauso*," with the view of navigating a ship in a calm.[2]

Jonathan Hulls.

In 1736, Jonathan Hulls made some practical progress in the idea so long floating vaguely in the minds of his predecessors, and, on the 23rd December of that year, secured a patent for his invention "of a machine for carrying ships and vessels out of or into any harbour or river against wind and tide or in a calm," of which the following is a sketch.



His specification[3] described how to drive a paddle-

[1] Gill's "Technical Repository," 1829, p. 251.

[2] "Specifications of Marine Propulsion," Woodcroft, vol. i. p. 21.

[3] The reader will find this plan described at length in Woodcroft's "Specifications of Marine Propulsion," pp. 23 and 34 (note). Hulls "placed a paddle-wheel on beams projecting over the stern, and it was turned by an atmospheric steam-engine acting in conjunction with a counterpoise weight upon a system of ropes and grooved wheels" (MacGregor).

wheel by converting a reciprocating rectilinear motion into a continuous rotary one. But though Hulls' mode of obtaining a rotary motion was new and ingenious, and would, perhaps, enable a steam-boat in a calm to be moved through the water, moreover is the first *steam-boat* authentically recorded, it was probably not such as could be made practically useful for the general purposes of commerce, and I have been unable to find any record of this or of any such vessel having been so used. At the same time, it must be added that boats not unlike Hulls' may now be seen trading in parts of the world remote from each other, as, for instance, on the Murray in South Australia, where various vessels, of which the following is an illustration, are employed, and on the

upper Thames where one, at least, to my knowledge is now worked, which does not seem to be any very marked improvement on the boat of Jonathan Hulls.[1]

[1] Jonathan Hulls was born at Campden, in Gloucestershire, in 1699, and made his first experiments on the Avon at Evesham. In 1737 he published a pamphlet entitled "A Description and Draughts of a New

In 1756, Gauthier, a French mathematician, wrote a treatise on "Navigation by Fire," which attracted the attention of the Venetian Republic.[1] But whatever merit some of these ingenious discoveries may have possessed, it was not till the 5th January, 1769, when James Watt obtained his patent, that any steam-engine could be effectually adopted in marine propulsion.

James Watt's engine.

Among various other improvements in the steam-engine patented by him, the most important was one for causing the steam to act above the piston, as well as below it, described as the "double impulse," or, now more commonly called, the double acting engine.[2] On the old principle, when the weight of the atmosphere had pressed down the piston, a valve opened in the bottom of the cylinder whereby a fresh supply of hot steam rushed in from the boiler, which, acting as a

Invented Machine;" in this he proposed to put a Newcomen engine on board a tow-boat to work a paddle-wheel placed in the stern

Mr. Smiles ("Lives of Boulton and Watt," p. 63) observes, "It has been stated that Newcomen took out a patent for his invention in 1705;" but this is a mistake, as no patent was ever taken out by Newcomen. It is supposed that Savery, having heard of his invention, gave him notice that he would regard his method of producing a vacuum as an infringement of his patent, yet the principle on which Newcomen's engine worked was entirely different from that of Savery.

[1] He died shortly after his arrival at Venice, and his plans were never put into practical operation.

[2] The now well-known principle of a steam-engine is this: there is a cylinder with its rod fixed to one end of a lever, which is worked by the combined pressure of the atmosphere and the steam upon a piston, a temporary vacuum being made below it by suddenly condensing the steam, which had been let into the cylinder where this piston works, by a jet of cold water thrown into it. A partial vacuum being thus made, the weight of the atmosphere presses down the piston and raises the other end of the straight lever, thereby drawing up water from a mine, or, by the numberless improvements made of late years, communicating a mechanical power which may set in motion every description of machinery.

pressure in excess of that of the atmosphere above the piston, combined with the weight of the pump rods at the other end of the lever, carried that end down, and of course raised the piston in the steam cylinder. The orifice for the emission of the steam having been then shut, and the cock opened for injecting the cold water into the cylinder, condensation took place, and another vacuum was made below the piston, which was again forced down by the weight of the atmosphere: thus the work was continued as long as water and fuel were supplied, and the steam-engine rendered capable of successful application for pumping purposes, a contrivance used even at the present day.[1] But the method contrived by Watt rendered the power of the engine much more effective by the use of a detached condenser, whereby the cooling of the cylinders by the injection of water was prevented and considerable economy obtained.[2]

Matthew Wasborough, however, an engineer of the city of Bristol, considering that something was still wanting to make the marine engine a proper instrument of propulsion in concurrence with Watt's improvement of the double acting cylinder, obtained, on the 16th March, 1779, a patent for a practical mode of converting a rectilinear into a continuous circular motion; one of his objects being to adapt his invention "for moving in a direct position any ship or vessel."[3] **Matthew Wasborough.**

[1] "Woodcroft on Steam Navigation," p. 14; "Cabinet Cyclopædia," Mechanics, p. 258.

[2] Letter to Dr. Small, with a drawing; Muirhead's "James Watt," London, 1854, vol. ii. pp. 4, 8, 11.

[3] There seems little doubt (see Lardner, p. 186, and Muirhead's "Life of Watt," p. 273, that Watt was the real inventor of the crank for which Mr. Wasborough obtained the credit. Mr. Watt says distinctly,

His invention, however, did not answer, and was indeed superseded by that of James Pickard, 23rd August, 1780, who, shortly afterwards entering into partnership with Wasborough, patented a method of working a mill with a rotary motion by means of the present connecting rod and crank and a fly wheel, constituting the second important improvement in the steam-engine, and enabling it to be of really practical service in propelling vessels. In 1781 (25th October), James Watt obtained another patent for his newly invented method of applying the vibrating or reciprocating motion of steam or fire-engines to procure a continued circular motion round an axis so as to turn the wheels of mills or other machines. This invention is known as the "Sun and Planet" motion.[1]

Marquis de Jouffroy.

In the same year (1781), the Marquis de Jouffroy is said to have constructed a steam-boat at Lyons 140 feet in length, and to have made with her several successful experiments on the Saone near that city. Mr. MacGregor, however, has made particular inquiries[2] into the authenticity of the claims of the Marquis, and, as no description of the machinery of this vessel is discoverable earlier than that given by himself thirty

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that, having noticed, in 1778 or 1779, certain defects in the "ratchet wheels" invented by Wasborough, he proceeded to remedy them, but having neglected to take out a patent for these improvements, a workman employed to make Mr. Watt's model told "some of the people about Mr. Wasborough," on which he took a patent for the application of the crank to steam-engines.

[1] In the Patent Museum, London, may be seen now (1875), the same "Sun and Planet" engine (a great curiosity), which Watt constructed in 1788 at Soho, near Birmingham.

[2] See "Specifications relating to Marine Propulsion" (Part II.), p. 109, in which the existing documents are recapitulated and described.

years afterwards, when he petitioned for the use exclusively of steam-boats for fifteen years, these claims are, to say the least, very questionable, while, in a report on his improvements, the invention is said to be Rumsey's, but more likely that of his own countryman Gauthier, whose death prevented his plans from being practically exemplified by the Venetian Republic. The French Revolution, however, supervening, the Marquis had not an opportunity of prosecuting his undertaking.

In 1785, Joseph Bramah, a man of great genius, and the inventor of the hydraulic press, obtained a patent for an hydrostatical machine and a boiler on a peculiar principle, in which the power of air, steam, or any other elastic vapour, might be employed for the working of engines. Another of his inventions is a mode of propelling vessels by the improved rotatory engine described in the specification, through the medium of either a paddle-wheel or what may be called a screw-propeller. Bramah shows a vessel with a rudder placed in the bow, and describes in his specification the nature of the "screw-propeller" and of its mode of action in minute and specific terms.[1]

Bramah's screw-propeller.

[1] There is more in Bramah's inventions than at first appears, and the scientific reader would do well to study that part of them referring to the "boiler." The following remarks have reference to the screw:—

"Instead of the (paddle-wheel) A, may be introduced a wheel with inclined fans or wings, similar to the fly of a smoke-jack, or the vertical sails of a windmill: this wheel or fly may be fixed on the spindle C alone, and may be wholly under water, where it would, by being turned round either way, cause the ship to be forced backwards or forwards, as the inclination of the fans or wings will act as oars with equal force both ways, and their power will be in proportion to the size and velocity of the wheel; allowing the fans to have a proper inclination, the steam-engine will also serve to clear the ship of

Although there is no record of Bramah having put his proposal into practice, the description lodged by him at the Patent Office is interesting, as showing clearly an indication of the now so well-known screw-propeller. Moreover, in this invention, he obviously intended that steam should be used so as to give circular motion to the propeller shaft. Previously, however, to the time when he patented his invention, the rotatory screw as a mode of propulsion had been proposed by Watt, who, in 1770, suggested the application of a screw-propeller to be turned by a steam-engine.[1]

But more than half a century elapsed before the screw, now in almost general use, was practically applied; indeed, the first authentic record we possess of the marine engine itself having been successfully worked by paddle or any other means on board any vessel, dates no further back than 1787, although, between 1774 and 1790, Fitch and Rumsey were experimenting in America on boats (to which I shall hereafter refer) to *work against streams.*

Mr. Miller of Dalswinton.

In that year (1787) Mr. Patrick Miller, of Dalswinton in Scotland, a gentleman of position and fortune, published a pamphlet (given at length by Mr. Woodcroft[2] in his interesting and instructive work on steam navigation, with copies of Mr. Miller's

water with singular expedition, which is a circumstance of much importance." This "apparatus for working the ship" is fixed in or beyond the stern, in or about the place where the rudder is usually placed, and its movement is occasioned by means of an horizontal spindle or axletree conveyed to the engine through the stern end of the ship."

[1] See letter to Dr. Small (who replies he had tried it); Muirhead's "James Watt," London, 1854, vol. ii. pp. 4, 8, 11.

[2] "Woodcroft on Steam Navigation," p. 20, *et seq.*

drawings illustrative of his scheme), on the subject of propelling boats by means of paddle-wheels *turned by men*, working on a capstan with five bars, each 5 feet long, which drove a water-wheel, having the same object in view as Messrs. Fitch and Rumsey, then engaged on similar works on the other side of the Atlantic.

This wheel, of which the following is a sketch, drove the vessel in a calm from 3 to 4 miles an hour; and, as Mr. Miller judged the capstan the best mode of turning the wheel, he rejected for a time all other modes, believing manual labour so applied more to be depended on than any mechanical contrivances. For the purpose of his experiments he built, from first to last, eight boats of different kinds, expending no less than 30,000*l.* on them and their machinery. One was a treble vessel, or rather three boats fastened together, of which the following is a transverse representation of the fore part with the lower floats of the wheels at their full dip.

According to a written statement laid before the Council of the Royal Society, London, December 20, 1787, Mr. Miller made various excursions in this vessel in the course of that year; being

attended in most of these by a Mr. James Taylor, the tutor in his family, who, being a man of considerable genius, urged Mr. Miller to apply steam to drive the wheels of his boat. At last Mr. Miller was induced to employ a young hard-working operative engineer, named Symington, to carry out Mr. Taylor's suggestion, and the combination of capital, energy, and genius with practical knowledge soon produced the desired results.

Mr. Symington and Mr. Taylor.

About this time Symington, who was employed at the lead mines at Wanlockhead, had succeeded in constructing a small steam-engine of a new description, originally intended for the purpose of propelling wheeled carriages, which he patented June 5th, 1787.[1]

His specification, accompanied by drawings, relates, 1, to heating the cylinder of a steam-engine; 2, loading the piston; 3, placing a fire round the cylinder; 4, a boiler; and, 5, "when rotatory motions of whatever kind are wanted, two ratchet wheels will be placed upon one or the same axis in such manner that, while the engine turns forward one wheel, the other will be reversed without impeding the motion or diminishing the power so as to be ready to carry on the motion by the time the other wheel begins to be reversed."

As this engine was considered suitable for the purpose Mr. Taylor had in view, Symington[2] under-

[1] "Specifications relating to Marine Propulsion," Part I. p. 36.

[2] It is clear that Mr. Symington is entitled to the credit of the application of steam-power to propel the paddles. Mr. Miller stuck to the capstan and manual labour, but, on one occasion, having been to see Symington's locomotive, he told him of his own invention, and of the difficulty he had with his paddles for lack of power. "Why don't you use the steam-engine?" was Symington's immediate remark.

took to perform the work and Mr. Miller agreed to employ him. When completed it was mounted in an oak frame and placed on the deck of one of Mr. Miller's pleasure-boats, a vessel 25 feet long and 7 feet wide, with two wheels, to be tested on Loch Dalswinton. The engine performed its work beyond their most sanguine expectations, driving the vessel at the rate of 5 miles an hour, though the cylinders were only 4 inches in diameter. After being used in cruising about the lake for a few days, the engine was removed from the boat and conveyed to Mr. Miller's house, where it remained as a piece of ornamental furniture for a number of years.

The accounts which appeared in the Scottish newspapers at the time[1] state that the first experiment was made on the 14th November, 1788, and with such success that it was resolved to repeat it on a larger scale upon the Forth and Clyde Canal. A double engine with cylinders 18 inches in diameter was consequently ordered to be built at Carron Iron Works, and, in November of the following year, it was fitted on board of another of Mr. Miller's vessels and tried on Dalswinton Loch. As, however, the floats of the wheels gave way, it was not until the 26th of December, by which time stronger wheels

Miller at once assented, but first constructed a double vessel, with the paddle-wheels worked by five men at the capstan amidships, and, in June 1787, the first experiment with her was deemed successful. A short time subsequently steam was directly applied, but, whether in consequence of Symington's remark, is not certain. Mr. Taylor, who is said to have suggested it, was an intimate friend and fellow-pupil with Symington at Edinburgh 1786–7. (Smiles' "Lives of Boulton and Watt," p. 438.)

[1] Dumfries paper; *Edinburgh Advertiser*, and the *Scot's Magazine*, vol. l. p. 566, November, 1788.

had been procured, that an opportunity was afforded for fairly testing the capabilities of this engine. From the accounts in the local papers of the period[1] the experiment appears to have answered thoroughly, though made under many disadvantages; a speed having been obtained of from 6½ to 7 miles an hour, which, in the words of the report, "sufficiently shows that a vessel properly constructed might accomplish 8, 9, or even 10 miles an hour easily."[2]

Such was one among the first efforts made in steam navigation. That they were considered to be of practical value may in some measure be determined by the fact that Mr. Taylor's widow was, a few years afterwards, awarded an annual pension of 50*l*., and that, in 1837, Lord Melbourne's administration presented 50*l*. to each of his four daughters, who were in reduced circumstances, Mr. Symington having previously (1825), in answer to his memorial to the Treasury for a pension (he, too, being almost penniless), been awarded 100*l*. as a gift from the Privy Purse, and subsequently a further sum of 50*l*. Poor Symington![3] What a miserable return for labours of such inestimable value!

Mr. Miller having expended a large fortune on

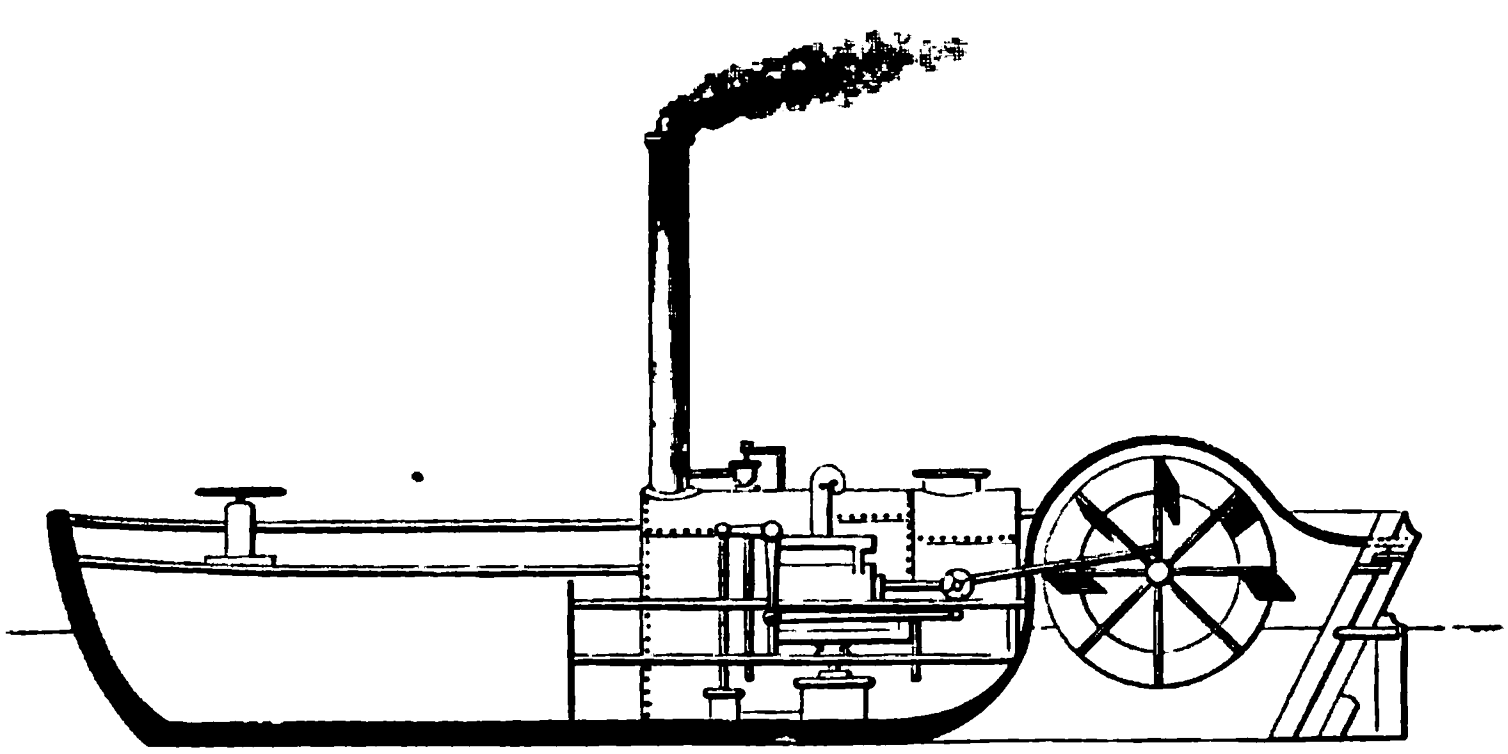
[1] *Caledonian Mercury, Evening Courant,* and *Advertiser.*

[2] In the Patent Office Museum, London, there may still be seen, "the parent engine of steam navigation, made for Patrick Miller, Esq., and used by him on the lake at Dalswinton, 1788." It consists of two small paddles, working one behind the other, to be fitted on the same side apparently of a small boat.

[3] From the narrative given by Mr. Smiles in his "Lives of Boulton and Watt," it is certain that they discouraged what they considered "speculative" adventures. Both were written to, with requests that they would make engines for Mr. Miller, those constructed by Symington not having answered as well as was expected, and both declined to have anything to do with the scheme. (Smiles, p. 445.)

these experiments, found it, no doubt, inconvenient to continue them, or having other projects in view, gave orders to dismantle the vessel in which his last experiment had been made, and laid her up with her engines at Bence Haven, at that time his property. More than ten years elapsed before Mr. Symington found another patron, indeed, it was not till 1801, that Thomas first Lord Dundas, employed him to fit up a steam-boat for the Forth and Clyde Canal Company, in which he was a large shareholder. Having availed himself of the many improvements made by Watt and others, Symington patented his new engine on the 14th of March of that year,[1] and fitting it on board the *Charlotte Dundas*, named after his lordship's daughter, produced, in the opinion of most writers who have carefully and impartially inquired into this interesting subject, "*the first practical steam-boat.*"[2] Mr. Woodcroft has furnished a sectional drawing of this vessel of which the following is a copy on a reduced scale;[3] it

The *Charlotte Dundas.*



[1] "Woodcroft on Steam Navigation," p. 54.

[2] "Encyclopædia Britannica" (eighth edition), vol. xx. p. 637.

[3] Mr. Smiles, in his interesting "Lives of the Engineers" (i.) states that,

resembled in many respects the description of vessel suggested by Jonathan Hulls, but not till now practically applied.

In March 1802, the *Charlotte Dundas* made her trial trip on the Forth and Clyde Canal. Embarking at Lock 20 a party of gentlemen, including Lord Dundas, and taking in tow two vessels or barges of 70 tons burden, she accomplished the trip to Port Dundas, Glasgow, a distance of 19½ miles, in six hours, or at the rate of 3¼ miles per hour, although it blew so strong a gale right ahead during the whole day that no other vessel on the canal attempted to move to windward.[1] Lord Dundas entertaining a very favourable opinion of the experiment, recommended the adoption of Symington's steam-boat in a letter of introduction to the Duke of Bridgewater, who gave him an order to construct eight vessels similar to the *Charlotte Dundas* to ply on his canal.

Elated by his success, Symington returned to Scotland to make arrangements for carrying out the orders of his Grace with the hope of realizing the

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in 1790, Lord Stanhope had proposed a mode of propelling vessels by steam, and had been in communication with Mr. Rennie on this subject, who, on the 26th April of that year, sent his Lordship such information as he could obtain about Boulton and Watt's improved steam-engine. Lord Stanhope objected to the space occupied by the condensing apparatus, to which Mr. Rennie replied that *high* pressure could be applied, on which his Lordship constructed a vessel on that plan which obtained a speed of 3 miles an hour (vol. ii. p. 237).

[1] Mr. Woodcroft observes that "this vessel might, from the simplicity of its machinery, have been at work to this day with such ordinary repairs as are now occasionally required for all steamboats," p. 53; and, again, "thus had Symington the undoubted merit of having combined for the first time those improvements which constitute *the present system of steam navigation*."

advantages his ingenuity and perseverance so well merited; but he was disappointed in his hopes, the Duke of Bridgewater died before the details of the agreement had been definitely arranged, and the Committee who had charge of the affairs of the canal after his death, came to the conclusion that it would not be advisable to use steamboats on it for fear of injury to its banks. We may presume that the Forth and Clyde Canal Company arrived at somewhat similar conclusions, for the *Charlotte Dundas* does not appear to have been again used.

Here it may be desirable to add that the *Charlotte Dundas* had an engine with the steam acting on each side of the piston (Watt's patented invention) working a connecting rod and crank (Pickard's patented invention)[1] together with the union of the crank to the axis of Miller's improved paddle-wheel, thus combining for the first time the essential characteristics of the existing marine engines: nevertheless, she was laid up in a creek of the canal near to Bramford Drawbridge, where she remained for many years exposed to public view, as a curiosity—doubtless, also, as a warning to speculators![2]

[1] Patented 23rd August, 1780. An invention in which the reciprocating motion of a beam acting on a connecting rod turns a wheel. Woodcroft, "Marine Propulsion," Part I. p. 32.

[2] It seems important to record that the success of Mr. Symington's engine consisted mainly in this: that, after placing in a boat a double acting reciprocating engine, he *attached his crank to the axis of the paddle-wheel*, a combination on which, as Mr. Woodcroft justly observes, "there has been no improvement even to the present time, either in this or in any other country." The power thus applied secured rotary motion without the interposition of a lever or beam. Mr. Symington might fairly claim, as he does in his patent of October 14th, 1801, that "the principle of this invention comprehends any species of machinery thus put in rotatory motion by a steam engine which may be made use of to navigate boats, vessels, or rafts."

Symington's limited means were now nearly exhausted, and the little that remained was expended in defending himself from attacks made on him by the relations of Mr. Taylor for having patented, as they alleged, the inventions of that gentleman. But the contentions of rival parties, *inter se*, rarely deserve commemoration except for the elucidation of the truth. It is, however, to be regretted that each of those persons who respectively contributed to the maturity of this invention, did not reap more material advantages from it in return for the time and labour they bestowed in perfecting a machine which has done so much for the benefit of mankind.

In 1797, an experiment in canal steam navigation, copied no doubt from Symington's original boat, was made in the neighbourhood of Liverpool, which is alluded to as follows in the *Monthly Magazine* for July of that year :—"Lately, at Newton Common in Lancashire, a vessel, heavy laden with copper slag, passed along the Sankey Canal without the aid of haulers or rowers, the oars performing eighteen strokes a minute by the application of *steam only!* After a course of 10 miles the vessel returned the same evening by the same means to St. Helens whence she had set out."

While these experiments were being made with success in Great Britain, and especially in Scotland, there were not wanting claimants—some of them of somewhat earlier date—to this great invention in other and distant parts of the world. To that of Gauthier we have already referred. In 1776, a countryman of his, Guyon de la Plombiere, suggested

the use of a steam-engine for propelling a vessel;[1] and, in that year, the Marquis de Jouffroy states he used, besides the one already mentioned, a steam boat (40 feet long and 16 feet wide) on the Doubs, with propellers moved by a chain from a single cylinder and counterpoise, which opened and closed like louvre boards;[2] applying, in 1780, an engine to his boat with a duck-foot propeller, two cylinders, inclined at an angle, and turned by a chain round a barrel.[3]

In 1782, Dixblancs sent to the Conservatoires des Arts et Metiers a model of a steamboat moved by a chain of floats carried on wheels at its sides turned by a horizontal cylinder;[4] and in 1796, it is stated that one Seraffino Serrati, an Italian, had some time previously placed a steam-boat on the Arno, near Florence.[5]

The Americans, as already stated, had, also, at an early period turned their attention to new modes of propelling vessels. In 1784, James Rumsey mentioned to General Washington a project of steam navigation, but, having been refused a patent in Pennsylvania, came to England and succeeded in inducing a wealthy countryman of his own, then resident in London, and others, to disburse the expenses of an experiment, for which he obtained a Rumsey and Fitch.

[1] "Encyclopédie Moderne," Paris, 1855, art. "Vapeur," p. 171.

[2] See "Des Bateaux à Vapeur," par Jouffroy (the son of the Marquis), pp. 13 and 17; and "L'Universel Dictionnaire Encyclopédique de la France," Paris, 1845, vol. ix. p. 737.

[3] Ibid., p. 737.

[4] Stuart's "Anecdotes of Steam Engines," vol. ii. pp. 450 and 483.

[5] "Elements of Experimental Physics," Florence, 1796, quoted by J. Scott Russell on "Steam and Steam Navigation," p. 238; also referred to nine years previously in "Lettere di Fisica Sperimentale," di Seraffino Serrati; Firenze, 1787, 12mo., and quoted in "Biographie Universelle," Paris, 1856, art. "Fulton."

patent in 1788. The particulars of his plan are given at length by Mr. Woodcroft[1] and will also be found in the Rolls Chapel Reports.[2] They were altogether impracticable for any useful purpose. In 1786, Mr. John Fitch, also an American by birth, proposed to use vertical oars worked by cranks turned by a horizontal steam-engine of which the following is an illustration.[3]

Although the Legislature of the State of Pennsylvania had, in 1784, turned a deaf ear to the applications of Messrs. Rumsey and Fitch, these gentlemen, in the following year, obtained from the Legislatures of Virginia and Maryland the exclusive right to run steamboats on the waters of those States, while Pennsylvania and New York having, in 1786, granted to Mr. Fitch himself similar exclusive rights, he in that year made a trial of his machine at Shepherdstown, Pennsylvania, in a boat of 9 tons, obtaining, it is said, the speed of 4 or 5 miles an hour against the current of the Potomac. In 1787, Mr. Fitch[4] built another vessel, 12

[1] "Steam Navigation," pp. 48–51.

[2] 6th Report, p. 179.

[3] See Brewster's "Encyclopædia," extracted from the *Columbian Magazine*, Philadelphia, vol. i., December 1786.

[4] John Fitch, who was a remarkable genius, was born in Connecticut, U.S., on the 21st January, 1743. His father, a small farmer,

feet beam, and 45 feet long, with a 12-inch cylinder, the mode of propulsion being somewhat similar, in which he is reported[1] to have made the trip from Philadelphia to Burlington at an average rate of

who could not afford to give him more than a limited education, bound him apprentice to a watch and clock maker. Afterwards he became a silversmith at Trenton, New Jersey, and, during the early part of the Revolutionary War, he was appointed by the "Committee of Safety" armourer to that State. Dislodged by the approach of the British, he fled to Bucks County, Pennsylvania; subsequently, he became a sutler, and supplied the American camp at Valley Forge with goods and provisions: he was also a land surveyor, and, in that capacity, the idea first suggested itself to him (as, curiously enough, it had done to Symington, in Scotland, about the same time) of propelling carriages by steam, but he soon abandoned it on account of the roughness of the roads in America, and turned his attention to propelling vessels by that power on the rivers.

In a sketch of his life, which appeared in the "Philadelphia Dispatch" of the 9th February, 1873, the writer, in describing the difficulties Fitch had to encounter in raising money to finish his second steam-boat, remarks: "In a letter to David Rettenhouse, when asking an advance of fifty pounds to finish the boat, he says, 'This, sir, whether I bring it to perfection or not, will be the mode of crossing the Atlantic in time for packets and armed vessels.' But everything failed, and the poor projector loitered about the city for some months, a despised, unfortunate, heart-broken man. 'Often have I seen him,' said Thomas P. Cope, many years afterward, 'stalking about like a troubled spectre, with downcast eyes and lowering countenance, his coarse soiled linen peeping through the elbows of a tattered garment.' Speaking of a visit he once paid to John Wilson, his boat builder, and Peter Brown, his blacksmith, in which, as usual, he held forth upon his hobby, Mr. Cope says: 'After indulging himself for some time in this never-failing topic of deep excitement, he concluded with these memorable words, "Well, gentlemen, although I shall not live to see the time, you will, when steam-boats will be preferred to all other means of conveyance, and especially for passengers; and they will be particularly useful in the navigation of the river Mississippi." He then retired, on which Brown, turning to Wilson, exclaimed, in a tone of deep sympathy, 'Poor fellow! What a pity he is crazy!'"

The same writer states that Fitch, in 1796, after his return from France, built, under the patronage of Chancellor Livingston, at New York, "a yawl, which he moved by steam with a *screw-propeller*, on the Collect Pond." Poor Fitch died by his own hands in 1798. See also "Life of John Fitch," by Thompson Westcott, published by J. B. Lippincott, Philadelphia, 1857.

[1] "New York Magazine" for 1790, p. 493.

7 miles an hour. In 1790, he completed another and a larger boat, propelled in a different manner: and, by referring to the *Federal Gazette and Philadelphia Advertiser*, of 26th July, 1790, the following advertisement will be found: "*The steam-boat* sets out to-morrow morning at ten o'clock from Arch Street Ferry, in order to take passengers for Burlington, Bristol, Bordingtown, and Fenton:" there is, therefore, no doubt that this boat actually traded with passengers on the Delaware.

But a glance at the second boat built by Fitch, of which the following is an illustration, will show

that the grasshopper paddles which he now employed, however well they may have answered for a time on the smooth waters of the Delaware, were not adapted for the general purposes of navigation any more than the treadles in his first invention.[1] Indeed, Fitch himself did not follow up the line of steam service he had commenced at so early a date, but on the invitation, as he alleged, of the French Government,

[1] "History of Philadelphia," by Thompson Westcott.

he soon afterwards visited Paris with the view of constructing vessels on his plan. As he was not, however, supplied with the necessary funds (no doubt arising from the fact that the French engineers were not satisfied with the practicability or desirability of his mode of propulsion) no vessel on his plan was built in France, and he was obliged to return to the United States, at the expense of the American Consul. As no further mention is made of vessels fitted on the plans[1] suggested by Fitch,

[1] Fitch himself thus describes the engines of his first boat in a letter which appeared in the Philadelphia newspaper of the period:

"*Philadelphia, Dec.* 8, 1786.

"SIR,—The reason of my so long deferring to give you a description of the steam-boat, has been in some measure owing to the complication of the works, and an apprehension that a number of drafts would be necessary in order to show the powers of the machine as clearly as you could wish. But as I have not been able to hand you herewith such drafts, I can only give you the general principles. It is in several parts similar to the late improved steam-engines in Europe, though there are some alterations. Our cylinder is to be horizontal, and the steam to work with equal force at each end. The mode by which we obtain (what I take the liberty of terming) a vacuum is, we believe, entirely new; as is also the method of letting the water into it, and throwing it off against the atmosphere without any friction. It is expected that the engine, which is a 12-inch cylinder, will move with a clear force of 11 or 12 cwt., after the frictions are deducted; this force is to act against a wheel of eighteen-inch diameter. The piston is to move about 3 feet, and each vibration of the piston gives the axis about forty evolutions. Each evolution of the axis moves twelve oars or paddles 5½ feet (which work perpendicularly, and are represented by the stroke of the paddle of a canoe). As six of the paddles are raised from the water six more are entered, and the two sets of paddles make their stroke of about 11 feet in each evolution. The cranks of the axis act upon the paddles about one-third of their length from the lower end, on which part of the oar the whole force of the axis is applied. Our engine is placed in the boat about one-third from the stern, and with the action and reaction turn the wheel in the same way.

"With the most perfect respect, sir, I beg leave to subscribe myself

"Your very humble servant,

"JOHN FITCH."

it may be inferred that they were not adapted for practical or useful purposes, or that the machinery was too complicated or too expensive to work remuneratively.

J. C. Stevens. In 1791, John Cox Stevens, of New York, commenced improvements on steam navigation; but it was not until 1804 that any of these were carried into practice; and even after an expenditure, as he states, of "twenty thousand dollars," and the constant devotion "of thirteen years of the best period of his life" to the project, he admits that his attempts were on the whole unsuccessful. These consisted of a plan for propelling a boat 25 feet long and 5 feet wide, by a rotatory engine, on the axle of which revolved a wheel, like a windmill or smoke-jack, worked at the stern, but he found it impossible to preserve a sufficient degree of tightness in the packing of the engine. A second modification of his rotatory apparatus proving on trial no better than the first, he had recourse to Watt's engine, omitting the beam, and having a cylinder 4½ inches diameter with a nine-inch stroke; the boiler, which was only 2 feet long, 15 inches wide, and 12 inches high, consisting of no less than forty-one copper tubes, each an inch in diameter. This boat (which is interesting as the first in which we have a direct account of the use of tubular boilers) was tried in May 1804, and attained a velocity of 4 miles an hour.[1] After having made repeated

[1] In a letter I received (May 2nd, 1875) from Commodore G. H. Preble, Commandant U.S. Navy Yard, Philadelphia, to whom I am indebted for much valuable information, he says, "John Stevens invented the twin screw-steamer in 1804, which is still preserved in the Stevens' Institute, Hoboken, N.Y."

trials with her, his son undertook to cross from Hoboken to New York, when, unfortunately, as she approached the wharf, the steam-pipe gave way. The boiler having also been damaged, he constructed another with the tubes placed vertically, and for this, perhaps the only portion of his invention worth securing, he, in the year 1805, obtained a patent in England,[1] where he then resided.

While Fitch and Stevens were employed in the manner I have described, another American citizen, Oliver Evans, an ingenious mechanic, was endeavouring to mature a plan for using steam of a very high pressure, to be employed in propelling waggons on common roads, and in an account of his plans which he published in 1786,[2] he suggests a mode of propelling vessels by steam. From this circumstance he has been regarded by some authors as the contriver of a practicable steam-boat: his pretensions, however, rest solely on his own allegations. He states that, in 1785, he placed his engine, used to cleanse docks, in a boat upon wheels, the combined weight being equal to 200 barrels of flour, which he transported down to the water, and, when it was launched, he fixed a paddle-wheel to the stern, and drove it down the Schuylkill to Delaware and up the Delaware to the city, "leaving all the vessels going up behind me at least half-way, the wind being ahead."

Oliver Evans.

In 1794, one Samuel Morey, of Connecticut, is

[1] The patent bears date 21st May, 1805, and was granted to "John Cox Stevens, of New York, but now residing in New Bond Street, Middlesex."

[2] Gill's "Technical Repository," 1829, vol. iv. p. 251 (for 1823), where a paper by Evans is given, but no further authority.

said to have built a steam-boat which he propelled at 5 miles an hour on the Connecticut River, and, in 1797, he built another, with side wheels, at Bordentown, New Jersey, which was publicly exhibited and made a passage to Philadelphia, but which does not appear to have been afterwards employed.

Robert Fulton.

In 1793, Robert Fulton, of whose exertions in the development of steam-engines and their early application to useful purposes[1] the Americans are justly proud, is said to have conceived some time previously the idea of propelling vessels by steam. It was not, however, until 1796 that any of his inventions were brought under notice: when, in that year, his plan for using small canals as a means of transit and for raising and lowering vessels on them by inclined planes was published. In the same year, 1796, it is said that he also suggested and used an apparatus for propelling vessels under water, to be employed in war,[2] but it was not until 1798 that he tried successfully to propel a boat with a steam-engine and a four bladed screw-propeller.[3] That he had shown an early taste for mechanical pursuits there can be no doubt, and, in 1801, when Napoleon contemplated the conquest of England, we know that Fulton made the friendly proposal to convey the legions of French soldiers who were to invade our shores by means of rafts propelled by steam; but, though the Emperor rejected the proposal

[1] Fulton invented the drop and the double-ended steam ferry-boats now in use in all the principal cities of the U.S.

[2] Stuart's "Anecdotes of Steam-engines," vol. ii. p. 478.

[3] Letter from R. Fulton in a memoir by E. Cartwright, London, 1843, p. 142.

as chimerical, Fulton, by his intercourse with the French Government, was afforded an opportunity of becoming intimately acquainted with Mr. Livingston, at that time Minister of the United States at Paris, with whom he frequently conversed on the subject of steam navigation, these communications having in the sequel very important results.

Mr. Livingston, who had previously been associated with Stevens in the United States in experiments and in various plans for promoting steam navigation, entered readily into the proposals of Fulton, and, on his suggestion, a boat was built on the Seine, the engine for which was ordered in England. This experimental boat, 66 feet long, and 8 feet wide, was completed in 1803. When on the point of making her first trial, the weight of the machinery broke the boat in two and both sank. They were, however, soon raised and the necessary repairs were shortly completed, but, on trial, the boat did not move with as much speed as Mr. Fulton expected.

And Mr. Livingston.

Before describing Fulton's further experiments, it may be convenient to direct attention to a statement made by Symington soon afterwards in the newspapers of the period, which remains uncontradicted, for the purpose of showing that whatever merit is due to Fulton, his information was derived from others.

Plan really derived from English experiments of Symington.

There is, indeed, no doubt that, in 1802, when Symington was conducting his experiments under the patronage of Lord Dundas, a stranger came to the banks of the Forth and Clyde Canal and requested an interview, announcing himself as Mr. Fulton of

the United States,[1] whither he intended to return, and expressing a desire to see Mr. Symington's boat and machinery, and to procure some information of the principles on which it was moved, before he left Europe. He remarked that, however beneficial the invention might be to Great Britain, it would be of more importance to North America, considering the numerous navigable rivers and lakes of that continent, and the facility for procuring timber for building vessels and supplying them with fuel; that the usefulness of steam-vessels in a mercantile point of view could not fail to attract the attention of every observer; and that, if he was allowed to carry the plan to the United States, it would be advantageous to Mr. Symington, as, if his engagements would permit, the constructing or superintending of the construction of such vessels would naturally devolve upon him. Mr. Symington, in compliance with the stranger's request, caused the

[1] Robert Fulton is said to have been born in Little Britain, Pennsylvania, in 1765. He was trained as an engineer, but having acquired some knowledge of portrait and landscape painting he came to England and studied under his distinguished countryman, West, with whom he continued to reside for several years; and, after quitting him, he made painting his chief employment for some time. He afterwards formed an acquaintance with Rumsey, and followed the profession of an engineer. He died 1815.—"Biographical Treasury," Longmans, 1873.

The following notice appears in the obituary of an American newspaper of the period:

"At New York, aged about 34 (50 years?) Robert Fulton, Esq., a great mechanical genius. He had been ill ten days, arising principally from exposure to the weather, in the pursuit of objects calculated, as our authority says, to increase the national greatness. These objects were steam-vessels of war, and a safe and certain method of submarine explosion. The first is so far completed, that it may be finished by other hands. Mr. Fulton was the inventor of steam-boats as they are now in use."

See note, Appendix No. 1. p. 587.

engine fire to be lighted, and the machinery put in motion. Several persons entered the boat, and along with Mr. Fulton were carried from where she then lay, to Lock No. 16 on the Forth and Clyde Canal, about four miles west, and returned to the starting-place in one hour and twenty minutes, being at the rate of six miles an hour, to the astonishment of Mr. Fulton and the other gentlemen.[1]

Mr. Fulton obtained leave to take notes and sketches of the size and construction of the boat and apparatus; but he never afterwards communicated with Mr. Symington. From the concurrent testimony of Mr. Jacob Perkins, and the oaths of those present in the boat during the experiment, it is evident that Fulton availed himself of the information obtained from Symington, and ordered from Messrs. Boulton and Watt of Birmingham, a steam-engine for propelling a boat intended to be built in the United States.[2]

In 1806 Mr. Fulton, in conjunction with Mr. Livingston, commenced building a steam-boat in America, in the yard of Charles Brown on the East (Hudson) River. She was decked for a short distance only at stem and stern. The engine was open to view, and a house, like that of a canal boat, was raised to cover the boiler and the apartments for the passengers and crew. There were no wheel-guards. The boiler was set in *masonry*. She was launched in the spring of 1807, and the engines ordered from Boulton and Watt[3] were

Fulton builds steamers in the United States.

[1] Woodcroft, pp. 64-65, Bourne, on "Steam Navigation," p. 14; and "Encyclopædia Britannica" (eighth edition), vol. xx. p. 638.

[2] Woodcroft, on "Steam Navigation," pp. 65-67.

[3] Woodcroft, on "Steam Navigation," with drawing of the vessel in question, p. 60.

fixed in that boat. The engine differed very little from that of the *Charlotte Dundas*, whose piston had a four-foot stroke, with a cylinder 22 inches in diameter, while that of the *Clermont* (as the American boat was named, after the residence of Mr. Livingston on the Hudson) had also a piston with a four-foot stroke, and a cylinder 24 inches in diameter. Such similarity in the dimensions of the engines could hardly have arisen from a mere accident.

But whatever information Fulton derived from Symington, he claimed no patent for the assumed discovery. On the first trial of the *Clermont* her speed was 5 miles an hour. Fulton perceiving that her paddles entered too deep into the water had them removed, and placed nearer the centres of the wheels. He afterwards made a further trip in her, leaving New York at one o'clock on Monday, and arrived at Clermont, the seat of Mr. Livingston, at one o'clock on Tuesday, performing in twenty-four hours a distance of 110 miles. On the voyage from Clermont to Albany, a distance of 40 miles, the time was eight hours, equal on the average of both passages to nearly 5 miles an hour.

The *Clermont*.

The *Clermont* was soon afterwards lengthened and considerably improved in appearance and usefulness—indeed, almost wholly rebuilt. Her hull was covered from stem to stern with a flush deck, beneath which two cabins were formed, surrounded by double ranges of berths, and fitted up for comfort in a manner then unexampled. Her dimensions now were, "Length, 130 feet; breadth, 16½ feet; with an engine of only eighteen horse-power,[1] though her

[1] The term horse-power is employed to express the magnitude or capacity and power of an engine. It originated with James Watt

burden was 160 tons, the boiler being 20 feet long, 7 feet deep, and 8 feet broad; the axle of her paddle-wheel was cast iron, but it had no outer support; the diameter of the paddle-wheels was 15 feet, and the paddles were 4 feet long, dipping into the water 2 feet.

It appears from a paragraph in the *American Citizen* (newspaper) of the 17th August, 1807,[1] that Mr. Fulton's original intention was to ply with his boat on the Mississippi; but the passenger trade on the Hudson then offered greater inducements. Various accounts have been given of the performances of the *Clermont*, but, without referring to these, it is better to furnish Fulton's own description of the trial, which he gave in a letter addressed to the above newspaper,"[2] as this is more

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from the actual measure of the work which a horse could perform, in raising 33,000 lbs. one foot high per minute; but as any such measure must, in the nature of things, be vague and fluctuating, it was replaced by what is now known as "nominal horse-power," a mode of measurement based mainly upon the area of the cylinder, the number of strokes per minute and the pressure. But this method is far from showing the actual horse-power, as some modern engines will give an effective power three, four, and even six times greater than the nominal; it serves, however, as a commercial unit of capacity or power of performance and regulates the price to be paid for an engine. But it is much to be regretted that nominal power is not yet estimated by an uniform standard, as different rules are still applied to condensing and non-condensing engines, and these vary in different places.

[1] "Mr. Fulton's ingenious steamboat, invented with a view to the navigation of the Mississippi, from New Orleans and upwards, sails to day from the North Run, near States Prison and Albany, the velocity of the steam-boat is calculated at 4 miles an hour. It is said that it will make a progress of two against the current of the Mississippi and, if so, it will certainly be a very valuable acquisition to the commerce of the Western States."—*American Citizen*, 17th August, 1807.

[2] "To the Editor of the *American Citizen*.

"New York, 21st August, 1807.

"Sir,—I arrived this afternoon at 4 o'clock in the steam-boat from

likely to be accurate than any other account, and has never been contradicted; indeed, had his statements been exaggerated, they would certainly have been questioned at the time, the more so that his great experiment was bitterly opposed by the owners of all the sailing-vessels then employed on the Hudson.

The following is a representation of the *Clermont* as she appeared on the Hudson after being im-

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Albany. As the success of my experiment gives me great hope that such boats may be rendered of much importance to my country, to prevent erroneous opinions, and give satisfaction to the friends of these useful improvements, you will have the goodness to publish the following facts:

"I left New York on Monday, at 1 o'clock, and arrived in Clermont, the seat of Chancellor Livingston, at 1 o'clock on Tuesday; time, 24 hours; distance, 110 miles; on Wednesday I departed from the Chancellor's at 8 o'clock in the morning, and arrived at Albany at 5 in the afternoon; distance, 40 miles; time, 8 hours! The sum of this is 150 miles in 32 hours, equal near 5 miles an hour.

"On Thursday, at 9 o'clock in the morning, I left Albany, and arrived at the Chancellor's at 6 in the evening. I started from thence at 7, and arrived at New York on Friday, at 4 in the afternoon; time, 30 hours; space run through, 150 miles, equal to 5 miles an hour. Throughout the whole way, going and returning, the wind was ahead;

proved,[1] and where she continued to ply with goods and passengers between New York and Albany for some years.

But though the *Clermont* was unquestionably a great practical success, and the first boat in the world regularly and continuously engaged in passenger traffic, she encountered many difficulties in her commercial operations.[2] In overcoming these difficulties and persevering with his novel undertaking, much credit is due to Robert Fulton; and though he was not, indeed he never claimed to be, the inventor of the steam-engine as applicable to marine propulsion, the manner in which various English authors of note have written,[3] and the tone in which an eminent English engineer has spoken of him, do not become men in their positions.[4] If

Merits and demerits of Fulton.

no advantage could be drawn from my sails. The whole has therefore been performed by the power of the steam-engine.

"I am, sir, your most obedient,

"ROBERT FULTON."

[1] Stuart's Anecdotes of "Steam-engines," vol. ii. p. 488.

[2] Fulton's second large boat on the Hudson was the *Car of Neptune*. Besides these two vessels he constructed steam ferry-boats to run between New York and New Jersey, also a boat for the navigation of Long Island Sound, as well as others for the Hudson, and for the Ohio and Mississippi.

[3] Mr. Woodcroft, in concluding his remarks about Fulton, disparagingly says that, "If these inventions separately (those borrowed from Watt, Pickard, and Symington) or, as a combination, were removed out of Fulton's boat, nothing would be left but the hull; and, if the hull be then divested of that peculiarity of form admitted to have been derived from Colonel Beaufoy's experiments, all that would remain would be the hull of a boat of ordinary construction. . . . Fulton's patents and specifications must, therefore, be considered either as mere importations, borrowed (in patent phraseology) from 'foreigners residing abroad' 'or as barefaced plagiarisms.'"

[4] In this judgment Mr. Woodcroft is supported by Mr. Rennie, who considered "Fulton a quack who traded upon the inventions of others." —Smiles' "Lives," vol. ii. p. 237.

we do not consider it necessary to be generous to the genius or, rather, to the persevering industry of men of other nations, we ought at least to be just, and not to overlook important facts or allow our judgment to be biased, because the man whose labours we are describing was not a countryman of our own.

Even when the fact is clearly established, and there is, without doubt, every reason to suppose that Fulton borrowed largely from Watt, Pickard, and Symington, and, it might be added, from his own countrymen, Fitch and Rumsey, this ought not to detract from his merit in putting all the inventions of these men and others together, and in first applying them to practical and useful purposes. He did what no other man had done before him: he commenced and *continued to run* the steam-ship which now traverses every river, every coast, and every ocean, and which, of all the inventions of man, is the mightiest harbinger of peace and good-will among nations the world has ever seen. If his was a combination of the inventions of others, if he were a "quack," it was only on a small scale compared to those persons who combine the inventions of men of all nations in the magnificent steam-engines of the present day. Do we, however, think less of any one of these engines when we see it in motion, and know that that beautiful machine, more like a living thing than any other work of man, is not the invention of any one man, or of any one nation? And ought we to think less highly of Robert Fulton when we know the labour he bestowed to collect the inventions of the age in which he lived, the hardships he endured to put them into

At all events, the first "to run" a steam-vessel regularly;

operation, and the difficulties he had to overcome in applying them to useful purposes?

That these difficulties were very great, so great indeed that to most men they would have been insurmountable, may be known from the fact that the *Clermont* was often, intentionally, run into by rival vessels on the river Hudson, and that the legislature was compelled to pass a law punishing by fine and imprisonment any person who attempted to destroy or injure her. Nor did his troubles end here. When the State of New York, convinced of the practical utility of his invention, granted him the exclusive privilege of navigating its rivers for a certain number of years, he was harassed by numerous law suits, and at last so thoroughly broken down by the oppressive influence of men of capital, who were either interested in the sailing-vessels, or in other inventions, that the State, in deference to the opinions of those sticklers who grudged him the merit of his labours, rescinded its concession, and passed a resolution that the boats built by Fulton were in substance the invention of his countryman, Fitch; a most unjust decision, as both of Fitch's modes, as I have shown, were valueless, while Fulton's were practicable.

and to develop its power and usefulness.

But, to whomsoever the invention belonged, the merit of first permanently developing its power and usefulness belongs to Robert Fulton. He it was who showed how it could be made not merely an instrument of vast importance to mankind, but also an immense source of profit to all who adopted it, though he himself, if reports be true, derived no advantage from it, but died in 1815 very poor and almost

broken-hearted through the persecution of jealous and narrow-minded rivals, leaving his family in greatly embarrassed circumstances, but at the same time leaving behind him an everlasting memorial of his energy and perseverance, and an enduring stigma on those who had taunted him with a "*Fulton's folly*."

The application of the new power to the propulsion of vessels was rapidly followed up in America, and, in 1809, the first steamboat was launched on the St. Lawrence of which an account at the time appeared in the *Quebec Mercury*.[1]

First steam-boat on the St. Lawrence, 1813.

In the spring of 1813, a second boat of increased dimensions was launched from the banks of the St. Lawrence. She was 130 feet in length of keel, and 140 feet on deck with a width of 24 feet, and by the account given by the *Mercury* she made the passage from Montreal to Quebec in twenty-two and a half

[1] "On Saturday morning, at eight o'clock arrived here, from Montreal, being her first trip, the steam-boat *Accommodation*, with ten passengers. This is the first vessel of the kind that ever appeared in this harbour. She is continually crowded with visitants. She left Montreal on Wednesday, at two o'clock, so that her passage was sixty-six hours, thirty of which she was at anchor. She arrived at Three Rivers in twenty-four hours. She has at present berths for twenty passengers, which next year will be considerably augmented. No wind or tide can stop her. She has 75 feet keel, and 85 feet on deck. The price for a passage up is nine dollars, and eight down—the vessel supplying provisions. The great advantage attending a vessel so constructed is, that a passage may be calculated on to a degree of certainty, in point of time, which cannot be the case with any vessel propelled by sails only. The steam-boat receives her impulse from an open, double-spoked, perpendicular wheel, on each side, without any circular band or rim. To the end of each double spoke is fixed a square board, which enters the water, and, by the rotary motion of the wheel, acts like a paddle. The wheels are put and kept in motion by steam, operating within the vessel. A mast is to be fixed in her, for the purpose of using a sail when the wind is favourable, which will occasionally accelerate her headway."

hours, notwithstanding that the wind was easterly the whole time and blowing strong. But though the *Swiftsure*, for such was her name, beat the most famous of the sailing packets on the line (fourteen hours in a race of thirty-six hours), her owners do not seem to have been very confident of her movements under all circumstances or of the number of passengers who would patronize her, for she was advertised to "sail as the wind and passengers may suit." The success of the *Clermont* for the purposes of passenger traffic on rivers soon, however, spread to other countries.

CHAPTER II.

Progress of steam navigation in Europe—Clyde mechanics take the lead—James Watt, 1766—Henry Bell, 1800—Correspondence between Bell and Fulton—Letter from Bell to Miller of Dalswinton—The *Comet* steamer, 1811, plies between Glasgow and Greenock, and afterwards on the Forth—Extraordinary progress of ship-building on the Clyde—Great value and importance of the private building yards—J. Elder and Company; their extensive premises, *note*—Steam between Norwich and Yarmouth, 1813; between London and Margate, 1815—The *Glasgow*—Early opposition to the employment of steam-vessels—Barges on the Thames—First steamer between Liverpool and the Clyde—H. M. steam-ship *Comet*—The *Rob Roy* and other vessels, 1818—The *United Kingdom*, 1826—First idea of iron ships, 1830—Proposals of Trevethick and Dickenson, 1809-1815—The *Vulcan*, 1818—The *Aaron Manby*, 1821—The Shannon Steam Packet Company, 1824—Mr. John Laird and Sir William Fairbairn—The *Elburkah*, 1832, and *Garry Owen*, 1834—The *Rainbow*, 1837—Messrs. Tod and MacGregor—The *Great Britain*, 1839–1843—Advantages of iron ships—Action of salt water on iron inconsiderable—Durability, strength, and safety of iron—Affords greater capacity for stowage—Admiralty slow to adopt iron for ships of war—Mr. Galloway's feathering paddles, 1829—Story of the screw-propeller—Joseph Bramah, 1785—Mr. J. Stevens, 1804—Richard Trevethick, 1815—Robert Wilson, 1833—Captain Ericsson, 1836—The *Francis B. Ogden*, though successful, fails to convince the Admiralty—Mr. T. P. Smith—The *Archimedes*—Her trial with the *Widgeon*, Oct. 1839, and its results—The *Rattler* and the *Alecto*, 1843—The *Rattler* not as successful as expected—Captain Robert J. Stockton efficiently supports Ericsson's views—His vessel, a complete success, and the first "screw" used for commerce in America—Superiority of Mr. Woodcroft's "vary-ing" propeller, 1832—In building fit vessels, the trade in which they are to be employed must be considered.

Progress of steam navigation in Europe.

DURING the progress in America of the art of practically applying steam to marine propulsion the

people of Europe were making slow but important improvements in the models of their vessels, and in the development of that art for the purposes of navigation.

In these improvements the mechanics on the Clyde took the lead, establishing there a reputation for the construction of marine engines and more especially of ships adapted to receive them, which they have ever since maintained. In the early part of this century the river Clyde in the vicinity of Glasgow was a scarcely navigable stream, with few or no vessels at its chief port, and these, small craft of not more than 40 tons, drawing, at most, only 5 feet of water when laden. Indeed, my own recollection of that now important river goes back to the time when one could wade across it among the stones at the foot of the old Broomielaw Bridge, and when a small but lucrative salmon fishery was carried on from the two "fishing huts," then the site where a dock now receives ships of the largest description, and where massive quay walls and numerous warehousing sheds occupy the once verdant grass banks of its southern shore. To the energy and intelligence of the Corporation, and, in later years, through the laudable exertion of a Trust, chosen from members of that body and other citizens of Glasgow, may, in a great measure, be attributed the extraordinary rise and prosperity of a city now possessing an inland navigation and a stream harbour unsurpassed, perhaps, in Europe. Indeed, from the time when James Watt, in 1766,[1] erected in Glasgow his first

Clyde mechanics take the lead.

James Watt, 1766.

[1] It would appear from Dr. Robinson's interesting narrative (Muirhead, "Life of Watt," p. 65), that Watt's first connection with the steam-

model of a steam-engine and there laid the foundation of a power which has since revolutionized the commerce of the world, its citizens seem to have specially directed their genius to the development of this mighty agency, their first and necessary step being the improvement of the approaches to their city by the deepening of the Clyde.

But it was not till the beginning of the present century that any real progress was made in the maritime pursuits of the people of Scotland. In

Henry Bell, 1800.

1800, Henry Bell, then resident at Helensburgh, first laid before the British Government his inventions for the improvement of steam navigation. The Board of Admiralty, however, so far from expressing any desire to promote his views, discouraged them, as they did thirteen years afterwards, when the subject was again urged upon their attention. Naturally anxious that his invention should be practically tested on a scale sufficiently extended, Bell forwarded, in 1803, a detailed account of his method of propelling vessels against wind and tide by steam power, to most of the European Governments, and also to the Government of the United States of America. He found, however, that his plans were received no better abroad than at home: while it further seems probable that the Government of the United States had either given or shown them to Fulton, who was then engaged in endeavouring to induce his countrymen to assist him in starting

engine arose from his having been desired, by the Professors of Natural Philosophy in the University of Glasgow, to repair a model of one of Newcomen's engines in the year 1764. (See Smiles' "Lives," p. 121.)

trading steamers on their lakes and rivers, where such vessels were admirably fitted for the profitable development of their vast natural inland resources.

Mr. Fulton evidently knew how Mr. Bell had been employed, for he opened a correspondence with him, and, in the course of it, requested him to call on Mr. Miller of Dalswinton, and on Mr. Symington, and to send him a drawing and description of their last boat with the machinery. These were sent out, and Fulton, some time afterwards, answered that "he had constructed a steamer from the different drawings of the machinery forwarded to him by Bell, which was likely to succeed with some necessary improvements." This letter Bell sent to Mr. Miller for his information. As the matter, however, to which it refers is one of considerable importance, it is desirable to state the facts as related by Mr. Bell himself in a letter which appeared in the *Caledonian Mercury* in 1816, wherein he says, referring to the communication he had received many years previously from Mr. Fulton: Correspondence between Bell and Fulton.

"This letter led me to think of the absurdity of writing my opinion to other countries, and not putting it into practice in my own country; and from these considerations I was [a]roused (*sic*), to set on foot a steam-boat, for which I made a number of different models before I was satisfied. When I was convinced they would answer the end, I contracted with Messrs. John Wood and Company, shipbuilders, in Port Glasgow, to build me a steam-vessel according to my plan: 40 feet keel, and 10 feet 6 inches beam, which I fitted up with an engine and paddles, and called her the *Comet*, because Letter from Bell to Miller of Dalswinton. The *Comet* steamer, 1811,

she was built and finished the year that a comet appeared in the north-west part of Scotland. This vessel is the first steam-boat built in Europe that answered the end, and is, at this present time, upon the best and simplest method of any of them, for a person sitting in the cabin will hardly hear the engine at work. She plies on the Firth of Forth, betwixt the east end of the great canal and Newhaven near Leith. The distance by water is 27 miles, which she performs in ordinary weather in three and a half hours up, and the same down."

In another communication, Bell says, "when I wrote to the United States' Government on the great utility that steam navigation would be to them on their rivers, they appointed Mr. Fulton to correspond with me."

No merit, as the inventor of the present system of steam navigation, can, however, be conceded to Bell more than to Fulton; nor for any progress beyond the improvements of which he had obtained cognizance from the previous experiments of Messrs. Miller, Taylor, and Symington. In fact, there can be no doubt, from existing drawings, that Symington's *Charlotte Dundas* was superior in mechanical arrangements to either Fulton's *Clermont* or Bell's *Comet*. But what Fulton and Livingston accomplished in the United States, Bell effected in his own country; each was, therefore, instrumental in the introduction, for commercial purposes, of steam navigation.[1]

plies between Glasgow and Greenock,

Though Mr. Bell had completed his *Comet* in January, 1812, more than six months elapsed before

[1] See Tredgold "On the Steam-engine," and Woodcroft, p. 82.

he announced to the public, through the medium of an advertisement in the local papers of the period,[1] his intention to employ her for trading purposes on the Clyde. The notice is a modest but curious and interesting document. He does not profess to make more than one passage each day between Glasgow and Greenock, a distance of 22 miles, and, doubtful of its pecuniary success, he informs the public that he intends to continue "his establishment at Helensburgh Baths," to which the *Comet* will carry passengers on her return journey from Greenock

[1] The following is a copy, from "Memorials of James Watt" by George Williamson, Esq., late perpetual Secretary of the Watt Club of Greenock, printed for the Club, of Mr. Bell's original advertisement of his newsteamer the *Comet* to ply between Glasgow, Greenock, and Helensburgh:—

STEAM PASSAGE BOAT, THE 'COMET,' between Glasgow, Greenock, and Helensburgh, for passengers only.

The subscriber having, at much expense, fitted up a handsome vessel to ply upon the River Clyde, between Glasgow and Greenock, to sail by the power of Wind, Air, and Steam, he intends that the Vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about midday, or at such hour thereafter as may answer from the state of the tide, and to leave Greenock on Mondays, Wednesdays, and Fridays in the morning to suit the tide.

The elegance, comfort, safety, and speed of this Vessel require only to be proved to meet the approbation of the public; and the Proprietor is determined to do everything in his power to merit public encouragement.

The terms are, for the present, fixed at 4*s.* for the best cabin, and 3*s.* the second, but beyond these rates nothing is to be allowed to servants, or any other person employed about the Vessel.

The subscriber continues his establishment at Helensburgh Baths, the same as for years past, and a vessel will be in readiness to convey Passengers that intend visiting Helensburgh.

Passengers by the 'COMET' will receive information of the hours of sailing, by applying at Mr. Thomas Stewart's, Bookseller Square; and at Mr. Blackly's, East Quay Head, Greenock; or at Mr. Houston's office, Broomielaw.

HENRY BELL.

Helensburgh Baths, 5th August, 1812.

This little vessel, of which the following is an illustration as she appeared on the Clyde passing Dumbarton, was designed and constructed by Mr. John Wood, shipbuilder, Port Glasgow. She was 40 feet in length of keel, and 10½ feet beam; her engines (which cost 192*l.*) were 4 horse-power; and her draught of water 4 feet. She continued to ply for a short time between Glasgow and Greenock, but under many difficulties.[1]

Though the engine of the *Comet* was only of 4 horse-power, driving two small wheels, one on each

[1] Mr. James Deas, C.E., in his "Treatise on the Improvements and Progress of Trade of the River Clyde," (1873) says, "An old gentleman, seventy-seven years of age, and who has been connected with the Clyde for upwards of fifty years, informed me a short time ago that he made a voyage in the *Comet* in 1812. He left Greenock at 10 A.M. for Glasgow, but, in consequence of a ripple of head wind, it was 2 P.M. before they got to Bowling, 10¼ miles above Greenock, where all the passengers were landed and had to walk to Glasgow, owing to the want of water, the tide having ebbed. It was no uncommon occurrence for the passengers, when the little steamer was getting exhausted, to take to turning the fly-wheel to assist her."

side, it must, however, have performed its work, on the whole, exceedingly well to have propelled a vessel of 30 tons burthen at the rate Mr. Bell states in his letter published in the *Caledonian Mercury*.

But the *Comet* does not appear to have proved remunerative to her enterprising owner on the line on which he had placed her.[1] The prejudice raised against steam navigation by rival interests, which Fulton had previously experienced on the Hudson, was equally strong on the Clyde, and seriously injured Mr. Bell's first undertaking. He was consequently obliged to withdraw her from this station and to employ her for some months as an excursion-boat on the coasts of Scotland and Ireland, extending his cruises to the shores of England when the weather permitted, to show the superior advantages of steam-boat navigation over other modes of transit to the public, many of whom viewed her with feelings of mingled awe and superstition. Afterwards he transferred her to the Forth, where she ran for a considerable time between the extremity of the Forth and Clyde Canal and Newhaven, near Edinburgh. Here she seems to have done her work most efficiently, for Mr. Bell states that she made the voyage, a distance of 27 miles, on the average, in three and a half hours, being at the rate of more than 7½ miles an hour.[2]

and, afterwards, on the Forth.

[1] Henry Bell, like too many of the pioneers of vast and truly important undertakings, failed to profit by the successful application of steam to navigation; and in his declining years he was chiefly supported by an annuity of 50*l*. granted him by the Clyde trustees. He died at Helensburgh in 1830, aged 63. ("Treatise" by Mr. James Deas, p. 24.)

[2] "Encyclopædia Britannica" (eighth edition), vol. xx. p. 638.

In the Patent Office Museum there is now to be seen the engine of the first *Comet* which carried goods and passengers on the Clyde. It was erected there in 1862 by the same engineer, Mr. John Robertson

Although the *Comet* at first proved commercially unsuccessful, there is no part of Europe where the progress in the construction of steamers has been either so great or so astonishing as on the Clyde. From a silvery salmon stream it has become in half a century by far the largest and most important shipbuilding river in the world; but, alas, its once limpid stream has long since ceased to be either silvery or pure.[1] Ancient historians have told us

of Glasgow, who fitted it in the *Comet*, exactly fifty years before that time. To this engine I shall again refer.

[1] When Smeaton first officially surveyed the Clyde in 1755, with a view to certain engineering improvements, he found the depth of the river, between Glasgow and Renfrew, of not more on the average than eighteen inches at low water—nor did he hope by the improvements then contemplated to obtain more than "4½ feet of water at all times up to the Quay at Glasgow;" but, in 1768, "the river," according to the report of another engineer, John Golborne, "was in a state of nature, and for want of due attention has been suffered to expand too much." He, also, did not expect to secure more "than 4 or perhaps 5 feet of water up to the Broomielaw" at a cost of "ten thousand pounds," a very considerable sum in those days to be raised by the citizens of Glasgow. Nor does Mr. Telford even, in 1820, hold out much hope of improvement, for in his report he remarks: "There does not appear to be any good grounds to expect such increase of revenue as to justify incurring any very considerable expense." But the corporation of the city, who had then the river under their charge, was happily not deterred by these disheartening reports from attempting further improvements, and, in 1824, Mr. James Reddie, their town clerk, in an able letter, called for further reports, which brought wiser engineering counsellors to their aid. By the indomitable energy of the corporation and the river trust, the Clyde was by degrees deepened; and at the Broomielaw, which only fishing wherries and small barges could reach forty years ago, the largest and most magnificent ships afloat, many of them more than 3000 tons register, drawing upwards of 20 feet of water, are now moored. See "Reports of the Improvement and Management of the River Clyde and Harbour of Glasgow." See also "Treatise" by Mr. James Deas, C.E., chief engineer to the river Clyde trustees, edited by Mr. James Forrest, C.E. (1873), pp. 31 and 32, where we learn that "during the last twenty-eight years, 1844 to 1872, no less than 18,000,000 tons of stuff have been dredged from the river by the Clyde trustees," and that the expenditure for dredging

that when the first Punic war roused the citizens of Rome to extraordinary exertions in the equipment of a fleet for the destruction of the maritime supremacy of Carthage, the banks of the Tiber resounded with the axe and the hammer, and that the extent of the ship-building operations then carried on was a matter not merely of surprise, but of wonder. How insignificant, however, was that sound when compared with that of the steam hammer and the anvil and the din of the work now to be heard on the banks of the Clyde. For miles on both sides of the river stupendous ship-building yards line its banks, employing tens of thousands of hardy and skilled mechanics earning their daily bread, as God has destined all men to do, by "the sweat of their brow," relieved from oppressive taxation, and free from anything approaching the thraldom of slavery, the curse of ancient Rome. Along those banks there is now annually constructed a much larger amount of steam tonnage than in all the other ports of Europe combined, those of England alone excepted. What a contrast to the days of Henry Bell!—days almost within my own recollection.

Extraordinary progress of ship-building on the Clyde.

By comparing the Clyde with the Tiber, both in themselves comparatively insignificant rivers—the one made important by the power of the Cæsars, the

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and depositing alone since the year 1770 has amounted to upwards of 500,000*l*. These dredging-machines are so complete and so superior to anything else of the kind to be found in any other part of the world, that I furnish, Appendix No. 2, p. 591, an account of them, their cost, horse-power, and other details. In 1800 the total amount of the annual revenue of the Clyde trust was only 3319*l*. 16*s*. 1*d*. In 1874, the revenue for that year, ending 30th June, amounted to 192,127*l*. 16*s*. 11*d*.

other by the wisdom and energy of the Clyde trustees, it is to be hoped that more than one lesson may be learned from the character of the employment on their respective banks. The clamour on the Tiber when Rome resolved to achieve maritime greatness, indicated war, terrible war, with Carthage; but the sounds on the Clyde proclaim a mission of peace and good-will among nations, for nearly all the ships constructed there are destined to carry to other lands the fabrics of our workshops and the products of our mills, and with them the civilizing and enlightening influence resulting from the skill and genius of our artisans.[1]

[1] In 1868 the total number of vessels built and launched on the Clyde was 232 of 174,978 tons, including 8 war vessels of 5384 tons; in 1869, 240 vessels of 194,000 tons, including 3 war vessels of 9100 tons; in 1870, 234 vessels of 189,800 tons, including 1 war vessel of 2640 tons; in 1871, 231 vessels of 196,200 tons, including 6 war vessels of 3050 tons; in 1872, 227 vessels of 224,000 tons, and no war vessel. (Treatise of Mr. James Deas, pp. 25 and 26.)

The vessels launched on the Clyde in the year 1873, are thus analyzed by Mr. William West Watson, the chamberlain of the city of Glasgow, in his report of the statistics of that city:

	No.	Tons.	Tons.
Iron steamers under 100 tons	14		1,076
„ from 100 to 500 tons	26		8,382
„ „ 500 „ 1000 „	13		9,786
„ „ 1000 „ 2000 „	22		34,315
„ „ 2000 „ 3000 „	24		60,026
„ „ 3000 tons and upwards	30		104,188
	129		217,773
Iron sailing ships under 500 tons each	2	328	
„ from 500 to 1000 tons	None		
„ „ 1000 to 2000 „	7	12,148	
	9		12,476
Hull or barge for shipment	1		198
Steamers shipped in pieces	3		2,459
1 screw steam yacht	1		20
	143		232,926

During the year 1873, the *Iberia*, gross tonnage 4670 tons, was

Should, however, the necessity arise, these numerous ship-building yards and thousands of mechanics could instantly be made available for the construction of vessels of war. If, therefore, a large naval force be still unhappily necessary, [and I am far from saying that it is not], should we not take into consideration, when we frame our naval estimates, the vast resources we have at our command in our private yards,[1] (infinitely greater as these are than those of all other nations in Europe combined), for producing on an emergency, whatever extra number of vessels of war we may then require? Our private building yards are in themselves the bases of a great fleet.[2]

Great value and importance of the private building yards.

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launched, being the largest merchant steamer ever built on the Clyde. Similar particulars for 1873–74 will be found, Appendix No. 3, pp. 593–4.

[1] See Appendices Nos. 3 and 4, pp. 593–9, "Shipbuilding Yards on the Clyde and Wear."

[2] One firm alone, that of John Elder and Co., Fairfield, Glasgow, who employ, on an average, 4000 men, launched in the year 1867 sixteen vessels of a total burden of 10,323 tons; and, in 1868, there were turned out from the Fairfield shipbuilding yard no fewer than fifteen vessels, of which six were sailing-ships and nine screw-steamers, the latter including a gunboat for the Royal Navy, and the *Magellan*, an iron barque of 3000 tons and 600 horse-power for the Pacific Steam Navigation Company. The total burden of the vessels launched from this one private yard in 1869 was 16,050 tons. In the following year (1870) fourteen steamers and three sailing-vessels were launched at Fairfield, measuring 25,235 tons, their engines having a total of 4115 horse-power nominal. There were likewise two steamers of 2600 tons transformed in the year. In 1871 they launched sixteen vessels of which twelve were steamers, amounting in the aggregate to 31,889 tons. In 1872 32,000 tons of steam shipping were built by this firm, and, in the course of that year, they had as many as sixteen vessels on hand at one time or contracted for, of an aggregate tonnage of upwards of 36,000 tons, six of them being about or above 4000 tons each: one of these was delivered to her owners complete and ready for sea, with steam up, within thirteen months from the time she was contracted for! These works, as may be supposed, are gigantic, covering upwards of 60 acres of land, and embracing a wet dock where the ships are placed when launched

J. Elder and Co., their extensive premises.

But the Admiralty are slow to learn. At the commencement of the century they declined even to consider the benefits to be derived by the application of steam, and even forty years afterwards, when everybody except themselves had become alive to its advantages, they refused to apply this new and now mighty power to our war ships of the line.

Happily, however, the great invention made its way without Government aid. Private enterprise carried into execution what the Admiralty would not even consider. In 1813 a steam-boat was built at Leeds, and was started to run between Norwich and Yarmouth in the months of August or September of that year. This was the second steam-vessel launched in British waters. In the same year a steamer was launched at Manchester and another at Bristol. In October 1814 another steamer commenced to ply on the Humber. In December of that year the first steamer was seen on the Thames; she was put in

Steam between Norwich and Yarmouth, 1813;

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to have their boilers and machinery fitted on board; an engine shop, 300 feet square; a blacksmiths' shop 296 feet in length and 102 feet in width containing 44 fires, one large plate furnace and four forging furnaces, six large steam hammers, and various hydraulic cranes. There are also in the yard two bays spanned by travelling cranes, each capable of lifting a dead weight of 40 tons; and among the numerous tools and machines there is one capable of planing armour plates of 20 feet in length and 6 feet in width, and one boring machine which can drill holes 4 inches in diameter, and penetrate a 9-inch plate in half an hour.

Here we regret to add, for we can ill afford to lose such men, that the head of this vast shipbuilding firm, and the man by whose remarkable genius it was founded, John Elder, died in September 1869 at the early age of forty-five. His father had been for many years the manager of the well-known works of Robert Napier and Co. There Mr. Elder served his apprenticeship and gained that practical knowledge which, combined with great natural abilities and an enthusiastic taste for mechanics, enabled him to create the very large business I have briefly attempted to describe.

motion on the canal at Limehouse; and, early in 1815, a vessel with a side lever engine of 14 horse-power, constructed by Cook of Glasgow, made her way from that city to Dublin, and thence round the Land's End to London. Though encountering great opposition from the Thames watermen, from time immemorial an obstructive class of men, she, nevertheless, commenced and successfully carried on a passenger traffic between that city and Margate. Cook had, in the previous year, in association with Bell, built two other steam-vessels, one of which, named the *Glasgow*, became in power and efficiency the standard at that time for river steamers.

Between London and Margate, 1815.

The *Glasgow*.

The public now began to appreciate the value of steamers. Prejudice vanished and travellers by them increased with such rapidity that, in 1816, it was not unusual for 500 or 600 passengers to enjoy, in the course of one day, water excursions on the Clyde.[1]

It is, however, not a matter for surprise that

Early opposition to the employment of steam vessels.

[1] Mr. Muirhead (in his "Life of Watt," pp. 428–9) mentions a few additional particulars which it seems worth while to record. Thus he states that the largest steamer built up to the year 1813 was the *Glasgow* noticed above, of 74 tons and 16 horse-power; and that, in 1815, the *Morning Star* of 100 tons and 26 horse-power, and, in 1815, the *Caledonia* of 102 tons and 32 horse-power, were severally launched. He adds that, during his last visit to Greenock in 1816, Mr. Watt made a voyage in a steam-boat to Rothesay and back, and showed the engineer how to "back" the engine, it having been usual previously to stop the engine for some time previously to mooring. He further states that, in April 1817, Mr. James Watt, Jun., purchased the *Caledonia* and, having refitted her, took her in October to Holland and up the Rhine to Coblentz; having thus been the first to cross the English Channel in a steam-boat. The average speed he obtained was seven and a half knots an hour. On her return to the Thames in 1818, Mr. Watt, Jun., made no fewer than thirty-one experiments with her on the river, resulting in the adoption of many material improvements in the construction and adaptation of marine engines.

steamers, when first placed on rivers for passenger traffic, were viewed with great jealousy by watermen, and that, on the Hudson and especially on the Thames, they were strenuously opposed. The traffic on the Thames had for centuries afforded profitable employment to large numbers of semi-seafaring men who, though not "sailors" in the usual acceptation of the term, could nevertheless be made much more useful on board our ships of war in an emergency than any other class in the community. To suggest any changes whereby their number might be reduced was sure, as has been the case for ages, to rouse the patriotic feelings of the people of England lest there should be a scarcity of men to man their fleets. Thus, on the repeal of the navigation laws in 1849, the special clause inserted in the Bill to reserve the coasting trade from the competition of foreign ships and foreign seamen, was *solely* on the ground of "preserving a nursery for British sailors," and five years elapsed ere that clause was expunged. When, therefore, the British Legislature, at so recent a period, considered it necessary to pass an enactment for the preservation of seamen in England, as if any law could retain them here if they were desirous of improving their condition by accepting employment elsewhere, it is not surprising that the watermen, bargemen, and others, who obtained their livelihood on the Thames, should have found many sympathisers in 1815, when they affirmed that their "trade would be ruined by the introduction of steamers." Nor can we wonder that men, in their humble position of life, could not see that the greater facilities afforded for intercourse between London and Margate and other towns on

the banks of the river would, so far from reducing their means of employment, tend very materially to increase them.

Previously to the time when David Napier introduced a steamer, the *Marjory*, to ply on the Thames, the passenger traffic of the river had been carried on by rowing boats, and sailing-craft of various descriptions. Those which made the more distant voyages to Margate, Ramsgate, and Deal were sailing-vessels, most of them carrying cargo as well as passengers, while many were merely barges, called Hoys, of which the following is an excellent illustra-

Barges on the Thames.

THAMES BARGE.

tion from Mr. E. W. Cooke's interesting collection of the vessels on the Thames. But the great bulk of them were wherries, while the larger class having a

mast and sails, plied between Greenwich, Woolwich, Erith, or Gravesend. A few were state barges—ornate structures—belonging to the Lord Mayor and Corporation, or to the different livery companies or ancient guilds, in which for centuries the members made frequent excursions to Richmond or Hampton Court on the one hand, and Greenwich or Blackwall on the other. Jovial pleasant parties they were, especially at that season of the year, when the horse-chestnuts in Bushy Park were in bloom, and white-bait was in its prime at Greenwich. One of these richly decorated barges, almost rivalling the celebrated bucentaur of Venice, I have copied from the drawings of Mr. Cooke as a relic of bygone days.

THE STATIONERS' BARGE.

But these have all now passed away, though the cargo barges, and some of the wherries may still be seen on the river. Steamers supply their places,

and from the time when Napier, in 1815, started his "fire-boat," steam navigation on the Thames, as on all other navigable rivers, has made a steady, if not, at first, a rapid progress.

First steamer between Liverpool and the Clyde.

On the 28th June, 1815, the first steamer arrived at Liverpool from the Clyde. She was built for the purpose of carrying on the passenger traffic between the Mersey and Runcorn. On her passage round she called at Ramsey, in the Isle of Man, whence she started early in the morning, and arrived at Liverpool about noon of the same day. This vessel, the particular dimensions and details of which it is difficult now to trace, was noteworthy in more ways than one. She was not merely the first regular steamer on the Mersey, but she was, also, in reality the pioneer of the fleet of steamers which now ply with so much regularity between Liverpool and the numerous ports on the English, Irish, and Scotch coasts.

The second steamer, introduced to the waters of the Mersey in 1816, was intended to supply communication for passengers and goods between Liverpool and Chester by means of the canal, an object she effectually accomplished.

The first application of steam for the purpose of towing vessels—now an important and invaluable part of the numerous services rendered by steam to navigation—was made in October 1816, when the *Harlequin* was towed out of the Mersey by the *Charlotte*, a steamer which, in the summer of the same year, had been placed as a ferry-boat to run between Liverpool and Eastham. But the first steamer specially built at Liverpool for the purpose of a ferry was named the *Etna*, which, early in April

of that year, began to ply between Liverpool and Tranmere. She was 63 feet long, with a paddle-wheel placed in the centre, her extremities being connected by beams, and her deck 28 feet wide over all. This primitive vessel initiated the mode of transit by means of the ferry-boats which now bridge the Mersey.

It was not, however, till the year 1819 that the Admiralty of the day became alive to the importance of steam navigation, nor were they likely, even then, to have awakened from their slumbers had not Lord Melville and Sir George Cockburn urged on the Government the great value of steam-power for towing their men-of-war.[1] In that year the first steam-vessel was built for the Royal Navy. She was named the *Comet*, and her dimensions were 115 feet in length, 21 feet in breadth, and 9 feet draught of water, being propelled by two engines of 40 horse-power each, manufactured by Boulton and Watt.

H.M. steam-ship *Comet*, 1819.

In 1818, Mr. David Napier, a name more associated than any other in Great Britain with the early development of the marine engine, having for some years previously been giving his attention to the propulsion of vessels by steam, launched the *Rob Roy* from the yard of Mr. William Denny, of

The *Rob Roy* and other vessels, 1818.

[1] At this period, Mr. Rennie, who planned the breakwaker at Plymouth and new London Bridge, was "advising engineer" to the Admiralty, and on every occasion urged the application of steam-power to vessels of war. More than this, he hired at his own cost the Margate steam-boat, the *Eclipse*, and successfully towed the *Hastings*, 74, against the tide from Woolwich to Gravesend, June 14th, 1819. On this the Admiralty, supported by Lord Melville, gave up their objections.—Smiles' "Lives," vol. ii. p. 267.

Dumbarton.[1] She was only 90 tons burthen, with engines of 30 horse-power, but, to the credit of her builder, she traded between Glasgow and Belfast, carrying with great punctuality the mails and passengers for two consecutive years without requiring any repairs; and although the first regular sea-going steamer which had been built in either Europe or the United States of America, her success was complete. Subsequently, the *Rob Roy* was transferred to the English Channel to serve as a packet between Dover and Calais. Soon afterwards Messrs.

[1] William Denny, the builder of the *Rob Roy*, as also of the *Marjory* (noticed p. 75), was born in Dumbarton in 1789, where his forefathers for some generations had been "wee lairds" (yeomen) farming their own land. After serving his apprenticeship as a joiner and ship-carpenter, and acting as manager of a small ship-building yard on the River Leven, Dumbarton, he commenced business on his own account at that place, and was the first to lay down in his yard Morton's patent slips, where he built various sailing-ships for the East and West India trades. He died in December 1833. Three of his sons, also, William, Alexander, and Peter, commenced business at that place as iron ship builders in 1844, on a small piece of ground, removing in 1847 to a larger yard, where they continued the business of iron ship builders under the firm of William Denny and Brothers, by which it is still known. In 1851, two other brothers, James and Archibald, having then joined them, they (there were seven brothers, all shipbuilders) commenced the business of engine builders, subsequently adding to this that of founding and forging, so that all the branches of work connected with steam shipbuilding might be done on the spot. William was a man of remarkable genius and talent, and attained so high a reputation as a marine architect that he and his brother Alexander planned most of the steamers built on the Clyde from 1839 to 1844. He died in 1854, and the only brother now left is the youngest, Mr. Peter Denny, who, with his son and Mr. Walter Brock, carries on this well-known and extensive business, which, in the years 1873 and 1874, built and fitted with engines 37,000 tons of iron screw-ships. Since 1844 the town of Dumbarton has risen, almost entirely through their exertions, from a population of 4000 to 12,000 inhabitants. But, beyond his fame as an iron ship builder, Mr. Peter Denny is known in public life, having been appointed a member of the Royal Commission in 1872 of which the Duke of Somerset was Chairman, to inquire into the cause of the loss of life and property at sea.

Wood, of Port Glasgow, built for Mr. David Napier, who had by this time removed to London, a boat named the *Talbot*, of 120 tons. She was fitted with two engines of 30 horse-power each, of his own construction, and proved in all respects the most perfect steam-vessel of the period. This was the first vessel placed upon the now celebrated line carrying the mails and passengers between Holyhead and Dublin.

The value of the steam-engine having now been fully established as a means of propelling vessels at sea with safety, and of performing voyages with a regularity hitherto unknown, Mr. Napier found comparatively little difficulty in inducing capitalists to join him in the project of constructing various vessels for a regular line of steam traffic between Liverpool, Greenock, and the city of Glasgow. Three vessels were, consequently, built—the *Robert Burns* of 150 tons, the *Eclipse* of 240 tons, each being fitted with two engines of 30 horse-power, and the *Superb,* also of 240 tons with two engines of 35 horse-power each. These vessels proved successful, and the line thus established in 1822 has continued ever since.

New coasting lines soon followed, and, in lieu of the Leith smacks, once so celebrated, the *James Watt* was constructed to ply between London and Leith. She was the largest steamer that had yet been built, being 448 tons measurement, fitted with engines of 50 horse-power each, by Boulton and Watt. Her paddles were moved, not directly by the engines, but, through the interposition of toothed wheels, rendering the number of revolutions of the axis considerably greater than that of the paddles, so that, with the exception of the low proportion of her

propelling power to the tonnage, she possessed many, if not most, of the qualities of the steamers of even the present day. The *Soho* followed the *James Watt* on the same line, and proved equally successful.

The *United Kingdom*, 1826.

In 1826 the first of the so-called leviathan class of steamers, the *United Kingdom* (of which the following is an excellent illustration) was built by

THE "UNITED KINGDOM," LONDON AND EDINBURGH PACKET.—FROM A DRAWING BY E. W. COOKE, R.A.

Mr. Steele of Greenock for the trade between London and Edinburgh. She was 160 feet long, with 26½ feet beam, and engines of 200 horse-power by David Napier, and was considered the wonder of the day. People flocked from all quarters to inspect and admire her.[1]

[1] In this vessel Mr. Napier introduced, for the first time in England, a

Although these two lines of regular steam communication between Liverpool and the river Clyde, and between London and Edinburgh were now successfully established, and proved of considerable importance in the encouragement of steam navigation elsewhere, some years elapsed before those rapid strides were made in its adaptation as a propelling power which have rendered it one of the wonders of the present age. Indeed, this power would probably

plan for surface condensation; the condenser was composed of a series of small copper tubes, through which the steam passed towards the air-pump, and a constant current of cold water encircling the pipes, the steam was cooled and returned into water, which was again sent into the boiler for conversion into steam, without being mixed with the cold salt water, which, in the usual plan, was injected into the condenser. But, like Watt, Cartwright, and others who had tried this system, both here and in America, Mr. Napier finding the rapidity of condensation not sufficient, returned to the old system of condensation by jet. Some years afterwards, however, he reverted to the use of a surface condenser under peculiar circumstances, which rendered it desirable to use flat plates instead of tubes, but the advantages of the system have not been considered sufficient to counterbalance the disadvantages. The first engine of Bell was to some extent a vertical engine, inasmuch as the axis of the cylinder and of the crank were placed in one vertical line; but there was no direct connection between the cranks and the piston-rod, to the paddle-axle: the communication of motion to it, being effected through the medium of toothed wheels. In the common or lever engine, the piston-rod acts on a cross-head, the cross-head on side rods, the side rods on side levers, the lever on a cross-tail, the cross-tail on the connecting-rod, the connecting-rod on the crank-pin, by which, through the axle, the paddle-wheels revolve. In the engine of direct communication, the side levers and some other parts of the train of communication are removed by a device which enables the piston-rod to be almost immediately attached by a connecting-rod to the crank of the paddle-shaft. This plan was first adopted by Mr. Gutznur, of Leith, who built the *Athol*, and another vessel called the *Tourist*, on this principle: but as his method, though very simple, was not applicable in ordinary cases, Mr. Napier made several modifications, so that his vertical engine, in the judgment of the most competent engineers, includes almost all the best improvements as yet introduced.

never have made such an extraordinary advance had iron not been adopted instead of wood for the construction of our ships.

Hitherto, and throughout all ages, timber alone had been used in shipbuilding. The forests of Lebanon supplied the naval architects of Tyre with their materials; Italy cultivated her woods with unusual care, so that sufficient trees might be grown for the timber, planking, and masts of the ships of its once powerful maritime republics; and, in our own time, how often have we heard fears expressed that Great Britain would not be able to continue the supply of sufficient oak for her royal dockyards, much less for her merchant fleets! Yet, when shrewd far-seeing men, no further back than the year 1830, talked about substituting iron for the "ribs" of a ship instead of "timbers," and iron plates for "planking" instead of oak, what a howl of derision the public raised!

First idea of iron ships, 1830.

"Who ever heard of iron floating?" they derisively enquired. It is true they might have seen old tin kettles float on every pool of water before their doors almost any day of their lives, nay, floating even more buoyantly than their discarded wooden coal boxes; but such common-place instructors were beneath their notice. Timber-built ships had from time immemorial been in use by every nation and on every sea, and had bravely battled with the storm from the days of Noah, and were these, they sneeringly asked, to be supplanted by a material which in itself would naturally sink? Such was the reasoning of the period; and indeed, the best of the argu-

ments against the use of iron rested on scarcely more solid foundation.[1]

It could not be gainsaid that a frame of iron was infinitely stronger than a frame of wood, which, in fact, has no strength in itself, for the longitudinal timber ends are only butted to each other, and obtain their power of resistance solely by means of the horizontal planks and the trenails which bind them together. Nor could the obstructives deny, though they argued the point, that the ribs when welded with the iron plates riveted to them, formed a hull vastly superior in strength, and much less liable to leakage than any similar body of wood, however well constructed. They must also have seen, by its displacement of water when afloat, that an iron hull was the more buoyant of the two. But these arguments, however unanswerable, were long ere they produced conviction; the fact that iron does not float, and the impression that it could not be made to do so safely, offered almost insuperable difficulties in the way of building vessels of that material; and when it was argued that they would "rip up" if they struck upon a rock, or bulge into a shapeless mass if driven on a sand bank, the opponents of progress

[1] In an able pamphlet, "The Fleet of the Future," by Mr. Scott Russell, published by Longman & Co. in 1861, the author remarks (p. 20), "A good many years ago I happened to converse with the chief naval architect of one of our dockyards on the subject of building ships of iron—the answer was characteristic, and the feeling it expressed so strong and natural that I have never forgotten it; he said, with some indignation, "Don't talk to me about iron ships, *it's contrary to nature*."

There was at one time almost as great a prejudice against Indian teak as a material for ship-building, as this wood is heavier than water, and in the form of a log will not float. (Arnott, "Elem. of Physics," p. 305.)

raised objections which could be answered only by practical experience.

Hitherto only a few very small vessels or barges had been constructed of iron, and these neither on a scale nor of a class to practically refute the objections which had been raised against the use of iron for ship-building purposes. It is true that so far back as 1809 Richard Trevethick and Robert Dickenson proposed a scheme for building "large ships with decks, beams, and sides, of plate iron," and even suggested "masts, yards, and spars, to be constructed of iron in plates with telescope joints or screwed together:"[1] and in 1815, Mr. Dickenson patented an invention for vessels, or rather boats, "to be built of iron, with a hollow watertight gunwale."[2] But, as these inventors or patentees did not put their ideas into practice, no other person (if, indeed, any other person gave even a passing thought to the subject) was convinced that any craft beyond a boat or a river-barge could be constructed of iron, much less that, if made in the form of a ship, this material would oppose more effectual resistance to the storms of the ocean, or, if dashed upon the strand, to the angry fury of the waves, than timber, however scientifically put together. But though no available substance can withstand the raging elements with less chance of destruction than plates of iron riveted together in the form of a boiler (the principle on which iron ships are now constructed), the public could not then appreciate

Proposals of Trevethick and Dickenson, 1809–1815.

[1] See "Rolls' Chapel Reports," 7th Report, p. 204.

[2] See "Repository of Arts," vol. xxviii. (second series), p. 138, and Woodcroft's "Specification of Marine Propulsion," Part I. p. 63, and "Steam Navigation," p. 125.

their superior value; and it was not until 1818 that the first *iron vessel* was built by Thomas Wilson, at Faskine, on the banks of the Monkland Canal, eleven miles from Glasgow: this vessel, appropriately named the *Vulcan*, is even now (1875) employed on the Clyde in the conveyance of minerals from the Forth and Clyde Canal.

The *Vulcan*, 1818.

Three years afterwards a steam-engine was, for the first time, fitted into a vessel built of iron. She was named the *Aaron Manby*, and was constructed in 1821 at Horsley, for the joint account of Mr. Manby and Captain Napier, afterwards Admiral Sir Charles Napier. She was sent in parts to London, where they were put together, and when complete was despatched to France under the command of Captain Napier. Another iron steam-vessel, intended for the navigation of the Seine, soon followed; but, in consequence of the prohibitory French navigation laws, with respect to foreign bottoms, the different parts of this vessel were, in this case, sent to France instead of to London, and put together at Charenton. Mr. Manby prepared in a similar manner two others, and shortly afterwards the building of iron vessels was commenced by an engineer at Paris for the same trade. The speculation, however, proved unfortunate.

Aaron Manby, 1821.

The Shannon Steam Packet Company was the next to employ iron steamers in river navigation. The first, built by the Horsley Company in 1824, proving very successful, was immediately followed by others.

Shannon Steam Packet Company, 1824.

As the success of these vessels was gradually determining the problem of the suitableness of iron to ship-building purposes, and was drawing attention

to the subject, Messrs. Fawcett and Preston established at Liverpool a building yard in connection with their engine factory under the direction of Mr. Page, and constructed several small vessels entirely of iron.[1] Mr. Laird, of Birkenhead, proceeding upon a larger scale, prosecuted this branch of naval architecture with uninterrupted prosperity.[2] Mr. Fairbairn, afterwards Sir William Fairbairn, also took part, at an early period, in cultivating the new art; and ranks with those to whose influence and skill it was first indebted for public confidence. Removing from Glasgow, where he had commenced business, he established himself at Millwall, on the Isle of Dogs, and there became one of the principal constructors of iron vessels upon the Thames. His efforts proving successful, other eminent engineers pursued the same branch of art with the like results; among them may be mentioned Messrs. Miller and Ravenhill, whose vessels were considered at the time to be of exquisite workmanship and beauty of form; and Messrs. Ditchburn and Mare, who built a considerable number of iron vessels, including the *Fairy*, the tender

Mr. John Laird and Sir William Fairbairn.

[1] Fincham's "Naval Architecture," on the use of iron for shipbuilding.

[2] William Laird, father of the late John Laird, M.P., established the Birkenhead Iron Works in 1824, under the style of William Laird and Sons, and, in 1829, they built for the Irish Inland Company the first iron vessel constructed on the Mersey. She was a lighter of 60 tons measurement, about 60 feet long and 13 feet beam. From that time until 1861, Mr. John Laird carried on this extensive business of shipbuilding and engineering, and when, in that year, he was elected to represent Birkenhead in Parliament, he transferred it to his sons, who now carry it on under the style of Laird Brothers.

Mr. Laird died in October 1874, about the same time as Sir William Fairbairn, another distinguished worker in the field of applied science, and both men of great eminence in their profession.

to the Queen's yacht, her form and speed gaining them a high reputation.

In 1832, Messrs. Laird were bold enough to carry into practice the theory of iron vessels for ocean navigation; and in the course of that year the firm of MacGregor, Laird, and Company built the *Elburkah*, of 55 tons, as consort to the *Quorra* in her expedition up the Niger.[1] These enlightened firms justly considered that, whatever objections might be urged against vessels built of iron, they would at least possess equal sea-going qualities and, in some branches of trade, peculiar advantages. Combining strength and lightness of draught, the *Elburkah* would be better adapted than any vessel built of wood for the exploration and navigation of African rivers:[2] nor were they deceived in their calculations. Immediately afterwards Messrs. Laird of Birkenhead commenced the construction of another iron vessel, the *Lady Lansdowne* for the navigation of Lough Derg, River Shannon. In 1834 they built the *Garry Owen*, destined to run between Limerick and Kilrush. This vessel (125 feet long and 21 feet 6 inches wide, propelled by two engines of 45 horse-power each) was unfortunately, or perhaps, under the circumstances, fortunately for the progress of science, driven on shore with various other vessels during a strong gale on her first voyage; she, however, sustained comparatively little injury, while

The *Elburkah*, 1832,

and *Garry Owen*, 1834.

[1] The *Elburkah* was 70 feet long, 13 feet beam, and 6 feet 6 inches deep. Her plates were a quarter of an inch thick in the bottom, and her sides one-eighth of an inch. She weighed only 15 tons, including her decks, but without engines, boilers, spars, and outfit. (See evidence, Mr. McGregor Laird before Select Committee on Steam Navigation to India (1834), p. 59.)

[2] Lardner ("Steam Navigation," p. 482) says that, in one of their

nearly all the others, which were built of wood, were totally wrecked or seriously damaged: this important fact, as a practical answer to one of the most reasonable objections raised against iron vessels, gave remarkable impulse to their increase.

But strong prejudices, unreasonable doubts, and real difficulties had still to be overcome before the suitableness of iron ships for ocean navigation could be established. Another of the chief and more tenable objections to the extended use of iron vessels was the perturbation of the compass. Moreover, one or two unfortunate accidents had been attributed to this cause, though this more, probably, served as a plausible excuse for bad seamanship or negligence. In the course, however, of a few years iron packets began to be used along our coasts; and the art of building them advanced gradually towards perfection. Iron vessels soon afterwards, therefore, acquired a merited confidence.

Their superiority had become apparent to the more intelligent persons of the period who directed their attention to engineering and maritime pursuits. In 1833 and 1834, Mr. Fairbairn launched two passenger steamers of iron to ply on the Humber between Selby and Hull. Mr. Manby also built one of considerable dimensions for general purposes; and in 1837 Messrs. Laird built two iron vessels of about 350 tons and 60 horse-power each, ordered

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experimental trials, the *Elburkah* got aground and heeled over on her anchor, and that in a wooden vessel the anchor would probably have gone through her; and, further that an iron vessel built for the Irish Inland Navigation Company, on being towed across Lough Derg, was driven on the rocks in a gale owing to the rope breaking; but, though she bumped for a considerable time, she sustained no injury.

by the East India Company for the navigation of the River Indus. In the same year Messrs. Laird constructed for the General Steam Navigation Company an iron vessel, the *Rainbow*,[1] to ply between London and the outports. In that year Muhammed Ali placed upon the Nile an iron steamer built by the same firm, while they also launched from their yard the iron vessels in which Colonel Chesney explored the course of the Euphrates, and which, having been shipped in pieces, were put together by Birkenhead artisans on the banks of that river.

The *Rainbow*, 1837.

Though the value of iron was now fully established for shipbuilding purposes, many years elapsed ere that material came into general use for the construction of over sea *sailing* vessels, the principal objections being the greater liability of the compass to err,[2] and the difficulty of preventing

[1] The *Rainbow* was, perhaps, the largest iron steam-vessel then afloat. She was 185 feet long, 25 feet beam, 600 tons burden and 180 horse-power.

[2] See a learned and able report on the "Deviations of the Compass," by Mr. Frederick J. Evans, Master R.N., Superintendent of the Compass Department of H.M. Navy, printed in the "Philosophical Transactions," Part II. 1860. In this interesting paper, Mr. Evans calls attention to one or two important facts, certainly not known to the general public, or perhaps not even to many shipbuilders. He says, p. 354:

"In an iron sailing-ship, built head to south, there will be an attraction of the north point of the compass to the head, and if built head to north, a like attraction to the ship's stern; and so far there would seem to be no advantage in one direction over the other. But, in the first case, the topsides near the compass have weak magnetism; in the second case, they are strongly magnetic: the first position seems therefore preferable.

"In an iron steam-ship, built head to the south, the attraction due to machinery is added to that of the hull, whereas in one built head to the north, the attractive forces of hull and machinery are, in the northern hemisphere, antagonistic, and a position of small, or no 'semicircular' deviation for the compass may generally be obtained. To iron steam-vessels engaged on the home or foreign trades in the

animalculæ and sea-weeds from adhering to the bottom. But these difficulties were in time overcome, and iron vessels propelled by sails are now nearly as common as steamers built of that material. Experience by degrees successfully met almost every objection; and science was again triumphant over prejudice and ignorance. Iron had been made not merely to float, but to ride buoyantly over the crest of the wave, amidst the raging elements.

Mr. Laird was followed by other builders of iron vessels at Liverpool; the high estimation in which they were held having led to a constantly increasing demand for them. About this time Messrs. Tod and MacGregor, of Glasgow, began to take a leading position in this occupation; the *Princess Royal*, long engaged on the line between Glasgow and Liverpool, and launched from their yard, having been one of the finest and fastest iron packets of her time. Messrs. Tod and Mac-Gregor.

From that period iron shipbuilding on the Clyde increased with great rapidity, but the most magnificent specimen of an iron ship of any description produced at that time was the *Great Britain*, to The *Great Britain*, 1839-1843.

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northern hemisphere, this direction of build is therefore to be preferred."

And, again, at p. 355, he remarks:

"As every piece of iron not composing a part of, and hammered in the fabrication of the hull,—such as the rudder, funnel, boilers, and machinery, tanks, cooking galleys, fastenings of deck houses, &c.,—are all of a magnetic character differing from the hull of a ship, their proximity should be avoided, and, so far as possible, the compass should be placed so that they may act as correctors of the general magnetism of the hull.

"A compass placed out of the middle line of the deck is affected by the nearest topside, and its deviations must necessarily be much increased if that topside has the dominant polarity, as in ships built east or west."

which reference will be made hereafter, constructed by Mr. Patterson at Bristol, for the Great Western Steam Packet Company.

Advantages of iron ships.

For the information of the general reader, I may here state that the advantages of iron vessels consist principally in their durability, strength and safety, increased capacity for stowage, greater economy, and salubrity.[1] With regard to the perturbations of the compass, Professor Airy, previous to the time when Mr. Evans made his report, had published a very concise series of instructions for correcting the compass on board of iron ships; and the progress of science now bids fair to obviate any difficulty whatever ensuing from this cause. Prior to experience it was apprehended that the saline property of the sea-water would tend to corrode the iron, and, further, that this metal would be rapidly destroyed by oxidation.

Action of salt water on iron inconsiderable.

But experience has shown that the effect of salt water on iron *alone* is so small as hardly to bear a comparison with its effect upon iron in connection with wood. This remarkable difference has been observed in iron vessels in which timber had been used for the keel; the bolts driven through the keel to form its proper connections having been so rapidly acted on as almost to destroy them before the external iron plates of the hull had been perceptibly diminished in thickness: it is further of importance that the vessel should be kept in use

[1] "The principal reason of an iron vessel being so much healthier is on account of her coolness and her freedom from all manner of smell; in an iron vessel there is no disagreeable smell of bilgewater, which there is in a wooden vessel in a tropical climate; it is, in fact, the difference between carrying water in a cask, and in a tank." (Evidence of Mr. McGregor Laird, p. 58, "Steam Navigation to India.")

rather than be laid up in ordinary. Vessels built in the earliest stage of this art, subsequently to that of building mere canal-boats, bore many years' service with little need of repair, and remained in a perfectly good condition for a longer period than that to which the durability of wooden vessels ordinarily, and under similar circumstances, extends. But there is a great difference in iron plates, some are inferior and soon oxidize, while others, as will be presently shown, last for many years. As the inner surface of the plates may be almost wholly protected from oxidation, it is only from the external wear that danger may be apprehended. But, though the outer surface of the metal can be protected in a great measure from corrosion, yet iron vessels are subject to the disadvantage of having their speed diminished, after a short period of service, by the adhesion and growth of animal and vegetable matter. A coating of red lead is not a perfect preventive against this mischief, and various other scientific substitutes have been used of late; so that it cannot be doubted but this inconvenience will disappear altogether before scientific appliances. A perfectly protective varnish for the insides of iron ships and a coating which shall effectually prevent the adhesion of animal and vegetable substances to the exterior, are desiderata of great value,[1] and will, we may hope, continue to receive the careful consideration of scientific men.

Durability, strength, and safety of iron.

All the facts yet known with regard to the supe-

[1] Mr. Robert Stephenson thought it possible, that if you had a dock filled with sulphate of copper, you might treat an iron vessel as you do a small teapot, and electrotype it with a thin coating of copper. (Evidence, 1851, 26th June, before Committee of the House of Commons.)

rior *durability*[1] of iron ships are highly satisfactory. It is a consideration not to be overlooked that large ships may be rendered more durable than small vessels; for, as the weight of the hull is generally determined in a certain proportion to the whole displacement, and the plates of iron are much thicker in a large than in a small ship (the oxidizing causing an uniform waste of metal), the durability will be in proportion to the amount of wear the plates of the respective vessels can bear without danger to the ship.

But the superior *strength* of iron ships depends not merely upon the quality of the material employed, but also on the mode of combining it. The strength of wrought iron is well known and its power of resisting strains in almost every direction is a matter of universal experience, add to which, that its resistance to lateral pressure increases in a much higher ratio than the quantity of material. Hence, almost any amount of strength may be given to a large fabric; certainly, enough to bear the pressures and strains to which ships are exposed, with much less liability to injury than wood. With plates of iron of a substance fitly proportioned to the magnitude of the fabric, and with joints properly formed, the sides of ships have been found capable of resisting, in a remarkable manner, forces for which the strength of

[1] The Liverpool underwriters, in their book of registry for iron vessels (established 1862), in the edition of that work for 1863 and 1864, offer the following remarks:

"Experience has shown that iron ships are much more durable than was at first supposed. By the use of cement inside, and by careful attention to outside coating, a well constructed iron ship can be reckoned upon to last, *in first-class condition*, for a period of at least twenty years. Wear and tear of equipment, and of the wood used in their construction, must in all cases be excepted."

timber would be quite insufficient. A substance of plates sufficient to constitute this amount of strength generally, is also able to bear concussions of great force with much less hazard than timber. The uninjured state in which the *Great Britain* was found in Dundrum Bay, after being wrecked and lying on the beach several months during winter, exposed to various storms, proved the correctness of these views, which more extended experience has since confirmed. Experience has also demonstrated that unless the concussion takes place with extreme violence, mere indentation of the metal is generally the greatest injury sustained. Beyond this, the strain sometimes breaks off the heads of a few rivets without opening the seam, but it is uncommon for the rivets to be drawn if the metal and workmanship are good. In the case where an iron ship strikes upon a sharp pointed-like crag of rock or coral reef with considerable force, it frequently happens that a hole is made through the plate; but even when such an accident occurs the damage is generally *local*, the parts not immediately subject to the concussion remaining unhurt. No general leakage is, therefore, consequent on such an accident, as would be the case in all vessels built of wood.

Affords greater capacity for stowage.

As the hull of an iron ship is both thinner and considerably lighter[1] than that of a wooden ship, an

[1] Mr. McGregor Laird states in his evidence (Question 553, p. 59) before the Select Committee on "Steam Navigation to India," 1834, "A strong iron vessel will not weigh one-half of that of a wooden one, and therefore will draw considerably less water;" further (Q. 554), "Her capacity for stowage will be much greater, her sides, including strong iron frames, not exceeding 4 inches in thickness, while those of a wooden vessel will be 12 inches thick."

"The average weight of the iron steam vessels is about 6 cwt. per

iron ship of the same external dimensions as a wooden one has both greater capacity for stowage and greater power to support the weights which may be put into her. These differences vary in some degree with the dimensions and form of the ship, being greater in proportion to the increased dimensions of the ship. They may, of course, be determined by computation; but, in all cases, an iron ship will carry considerably more cargo than a wooden one of the same external dimensions.

Again, the consideration of economy must not be omitted in any comparison of the merits of ships built entirely either of timber, or of iron. The economy begins with the construction, for the original cost of an iron ship is less than that of a wooden one, and, apart altogether from her superior capacity for cargo, it runs on with the course of the ship's service as the result of several causes; as, for instance, the smaller amount and less expensive character of repairs: moreover, as it is not even yet known how long iron ships will last, the precise saving from their use cannot be estimated. On the other hand, the period of service of mercantile timber-built ships is defined. If they reach or exceed thirty years' service, they must be ships of the very highest class as to quality,[1] and must, indeed, within that

register ton; a wooden one will weigh about 20 cwt. and upwards."—(See evidence of C. W. Williams, Appendix to Report of the above Committee, p. 43.) See *note*, Appendix No. 5, p. 599.

[1] The greatest number of years originally allowed by "Lloyd's Register" for the classification of any vessel built of wood to remain on the first class, was from four to sixteen years, but seldom more than twelve from the date of construction; they might be renewed, but the original term never exceeded the periods I have named.

period have undergone frequent and very expensive repairs. As iron ships are not subject to the same decay, at the same time that accidental damages are generally repaired at a much less cost, every item saved by the diminished charge for repairs is clear profit.

Admiralty slow to adopt iron for ships of war.

But with all these advantages, a considerable time elapsed before the Admiralty could be induced to consider the desirability of constructing any Government steamer of iron, or of even allowing the large private trading vessels engaged in the conveyance of the mails to be built of that material. They had objections of their own applying specially to the ships under their control, and very plausible objections too, in their opinion, compared with those originally raised by an ignorant public. A shot, they said, would penetrate an iron vessel with much greater ease than a wooden one, while the shot holes could not be as effectually plugged, if indeed they could be plugged at all. Wood, they argued, when pierced, would rapidly contract and leave a very small opening for water to get through, whereas a shot would make a clean cut through an iron plate which could not be thus expeditiously filled, and if it did not tear away the whole of the plate, would leave a gap as large as a "barn door." However, a little experience[1] soon showed their arguments to be fallacious, and when

[1] Captain (now Admiral Sir) W. H. Hall, R.N., in his evidence before Lord Seymour's (now the Duke of Somerset) Committee on Navy Estimates which sat in 1848, stated (p. 648) that, when he commanded the *Nemesis*, an iron vessel engaged in the Chinese war, she was in one action struck fourteen times by the shot of the enemy; "one shot went in at one side and came out at the other, it went right through the vessel;" there were "no splinters;" "it went through just as if you put your finger through a piece of paper." "I had," he added, "a favourable opinion of it" (iron). "Several wooden steamers," he continues, "were employed upon the same service, and they were invariably obliged to lie up for repairs, whilst I could repair the *Nemesis* in

they found that the engines of a paddle-wheel steamer, and, especially, the paddles themselves, offered conspicuous targets to an enemy, and that it was impossible to make the stern-frames of their wooden ships sufficiently strong to withstand, without serious leakage, the vibration of the screw, they abandoned, though reluctantly, the paddle-wheel, and at length gave up, also, vessels of wood for the purposes of war. These resolutions were, however, only carried into practice after vast sums of money had been expended on the "reconstruction" of a *wooden* British Navy, for which, in one year alone, and that so lately as 1861, when almost everybody except themselves saw that iron must supersede timber, they demanded from Parliament (and carried their vote) no less than 949,371*l.* to replenish the stock of wood in the dockyards; a sum far in excess of any previous vote for that material.[2]

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twenty-four hours and have her always ready for service; indeed, many steamers were obliged to leave the coast of China and go to Bombay for repairs. Repairs which would have taken in a wooden ship several days, would take in ours as many hours only."

Captain E. F. Charlwood, who had served in iron vessels "about four or five years," stated, in his evidence before the same Committee, that the *Guadaloupe*, which he commanded, had been repeatedly struck by shot, and that "the damage was considerably less than is usually suffered by a wooden vessel," and that "there was nothing like the number of splinters which are generally forced out by shot sent through a wooden vessel's side." He added that the shot went clean through (the holes being plugged by the engineer at the time), and did not otherwise injure the plates or leave a rent or displace any of the rivets.

[2] The author moved that the vote should be reduced by 300,000*l.* (see "Hansard's Parliamentary Report" for May 23rd, 1861, page 30, where his reasons are given), but, after a long debate, he was defeated, only thirty members voting with him, and sixty-six against any reduction. The reader will find what became of this timber (a large portion lay rotting in the dock-yards) if he refers to the Report of the Committee, appointed on the motion of Mr. Seely, some years afterwards. But, beyond the reasons then given by the author, the Admiralty or their

Mr. Galloway's feathering paddles, 1829.

While the art of steam navigation made rapid progress, the ingenuity of engineers had been constantly directed to the improvement of the paddle-wheels; and the above drawing of one, with "feathering paddles," patented by Mr. Galloway in

practical advisers must have known, long before 1861, that a screw-ship built of wood was vastly inferior to one constructed of iron; that the action of the shaft of the screw would prevent wooden vessels from lasting through a succession of long voyages without very considerable repairs from the vibration in the after body; and that the wood, by frequent concussion and constant working, would gradually lose its power of resistance, the fibres becoming bruised and compressed, which would not be the case with an iron ship, at least to anything like the same extent. Indeed, the naval constructors ought frankly to have told their Lordships that it would be unsafe to send a wooden ship to sea fitted with a very powerful propeller. No stern framework could be built to resist the vibration of the largest class of engines now in use in the navy. An iron ship, moreover, affords a much better and more solid foundation for the engines.

1829,[1] represents the most perfect of any wheel in use at that period, and has not been materially improved on since then. But, at that time also, a substitute for the paddle was seeking practical solution. The screw, as a means of propulsion, had been suggested long before the steamboat had been brought into use. Indeed, its principle was known at a very early period in the use of an oar for sculling, and could, as already explained, be seen in the movements of the tail of a fish.

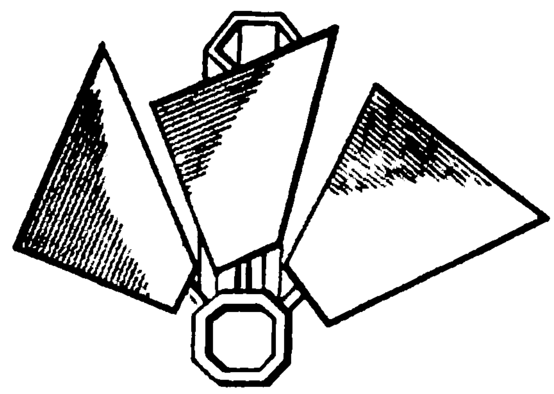
Story of the screw-propeller.

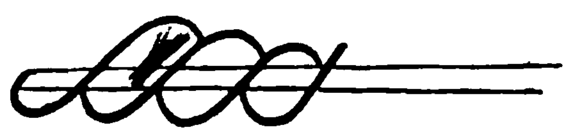
Though my faith in the reports of the genius and early inventions of the Chinese has frequently been rudely shaken in the course of my investigation of their reputed discoveries, I may remark that Mr. MacGregor, for whose opinions I entertain no ordinary respect, states, in the paper he read to the Society of Arts,[2] that "the use of the screw-propeller may be of an indefinite antiquity," and adds that "a model of one was brought from China in 1680, which had two sets of blades, turning in opposite directions." It was not, however, until 1729, that we have any authentic account of a plan of propulsion, in any way approaching the valuable invention now so largely in use. In that year an ingenious Frenchman, M. Du Quet, described a contrivance by which a screw turned by the water in a stream, wound up a rope for towing vessels, of which the annexed (p. 101) is an

[1] Dr. Lardner ("Steam-engine," p. 479) observes that, "when first introduced by Mr. Galloway, each board was divided into six or seven parts; this was subsequently reduced, and in the more recent wheels of this form constructed for the Government vessels, the paddle-boards consist only of two parts coming as near the common wheel as is possible, without altogether abandoning the principle of the split-paddle."

[2] April 14th, 1858.

illustration.[1] In 1745, Masson describes an apparatus for working an oar at the stern of a vessel so as to give it a "sculling" motion; in 1746 Bougner mentions that "revolving arms, like the vanes of a windmill," were tried for the propulsion of vessels, and, in 1770, as already incidentally noticed, the celebrated Watt speaks of using a screw-propeller, of which the annexed is a sketch, to be turned by a steam-engine.[2]





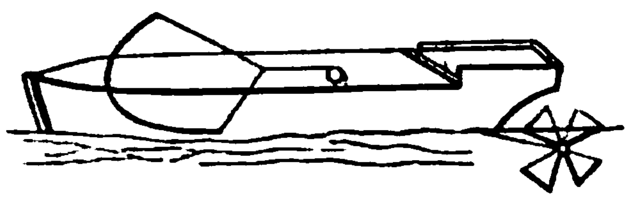
In 1779, Matthew Wasborough, to whose genius we are indebted for many inventions in connection with marine propulsion, patented a "new invented machine or piece of mechanism which, when applied to a steam-engine or any reciprocal movement, produces a circular or rotative motion without the medium of a water-wheel;" Joseph Bramah, of whose invention I have already spoken in detail, speaks of (1785) a wheel with inclined fans or wings, similar to the fly of a smoke-jack, which may be turned round either way under water, causing the ship to be forced backward or forward,"[3] and, in 1798, he tested the applica- **Joseph Bramah, 1785.**

[1] See Tredgold "On the Steam-engine;" Appendix D, 1842, p. 292; Woodcroft's MS. Collection, p. 22; Bourne "On the Screw-propeller," p. 8, and other writers.

[2] Woodcroft's "Specifications," p. 1, n., pp. 25 and 28. Ibid., pp. 31 and 34.

[3] It would appear that his experiment was successful if reliance can be placed, as I have no reason to doubt, on the accuracy of a letter from Mr. Fulton, in the memoir by E. Cartwright, London, 1843, p. 142

tion of a screw in a boat, of which the annexed, copied from Mr. MacGregor's instructive paper, is an illustration.



In 1800, Edward Shorter patented an invention which he called "a perpetual sculling machine," having the action of a two-bladed propeller, and which, two years afterwards, was experimented upon in H.M. Ships *Dragon* and *Superb*.[1] Various other experiments followed. But, in May 1804, Mr. J. Stevens, of the United States, put to sea with a steam-boat propelled by a screw, turned first by a rotatory engine, and then by Watt's reciprocating engine; and, as this small craft steamed from Hoboken to New York, she has by some writers been considered the first sea-going screw of which there is any certain account. Richard Trevethick, in 1815, patented "a worm or screw revolving in a cylinder at the head, sides, or stern of a vessel," as also a "*stuffing-box*, inclosing a ring of water."[2] In the following year Robert Kinder applied for a patent for a shaft and screw (almost on the exact plan now in use) with "a shoulder formed upon it so as to work in a water-tight manner through a stuffing-box of the common or well-known form, which stuffing-box and shaft are made to pass through the end of the vessel, just above its ordinary water-line, and is thereby affixed to it." (See "Specifications of Marine Propulsion," Part I. p. 64.)

Mr. J. Stevens, 1804.

Richard Trevethick, 1815.

Many other proposals for propelling vessels by

[1] Woodcroft "On Steam Navigation," p. 54; with drawing; Bourne "On the Screw-Propeller," p. 12; and accounts of trials which appeared in the newspapers, 1802.

[2] Woodcroft "On Steam Navigation."

means of the screw were subsequently made and most of them were patented.[1] Two were tried on a small scale in France by Captain Delisle, a Frenchman, in 1823, and by a countryman of his, M. Frédéric Sauvage, in 1832.[2] In 1833, Mr. Robert Wilson, a Scotchman, afterwards manager of Robert Wilson, 1833.

[1] As one more conspicuous than any other, it must be stated that, in March 1832, Mr. Bennet Woodcroft patented an "increasing screw-propeller," which he thus describes: "A spiral worm blade or screw coiled round a shaft (this resembles the invention of Watt) or cylinder of any convenient length and diameter, in such form that the angle of inclination which the worm makes with the axis of the cylinder continually increases, and the pitch or distance between the coils or revolutions of the spiral, continually increases throughout the whole length of the shaft or cylinder upon which the spiral is formed." (Specifications of "Marine Propulsion," Part II. p. 112.)

[2] The number of claimants to every important invention is remarkable. An impartial student will, however, probably come to the conclusion that the invention of the screw and its application was, like that of the steam-engine itself, the sole property of no one man, as he finds by research that experiments to discover the means of applying the screw as a motive power to ships were at different periods spontaneously and independently made in various places by inquiring minds, who frequently were perfect strangers to each other and to each other's discoveries or appliances; yet, as time passes on, and the labours of others are forgotten, a nation or a town claims for some one of its countrymen or townsmen who may have experimentalised on an invention which has become of great use to mankind, the sole or the largest share of the credit of the invention, and erects in their midst an enduring monument of his fame. Such would appear to be the case of Frédéric Sauvage, who has just (October, 1874) had a statue erected to his memory in the town of Boulogne-sur-Mer, where he was born on the 20th of September, 1786. On either side of the monument (which is 14 feet high surmounted by a large bronze bust of M. Sauvage) is an inscription setting forth the date of his birth and of the translation of his remains, together with a list of his inventions. On the front are the two words "Frédéric Sauvage," and a bronze bas-relief showing a vessel with a screw-propeller. Frédéric Sauvage's life was similar to those of many other inventors, in that he spent his days and fortune in perfecting inventions which brought him no profit. Having lost his own money, he borrowed from others, and, being unable to repay, was thrown into a debtors' prison, which he afterwards exchanged for a madhouse, where he died on the 19th of July, 1857.

the firm of Nasmyth and Co., at Patricroft near Manchester, brought under the notice of the British Admiralty the screw "perfect in all its details" as a means of propulsion, which he says he invented in 1827, and which he states[1] the officers of the Woolwich Dockyard, in their official report, rejected because "it involved a greater loss of power than the common mode of applying the wheels to the side." No great efforts, however, seem to have been made to bring the screw into practical use until 1836, when Captain John Ericsson, C.E. (a native of Sweden, who had established himself in London in partnership with the Messrs. Braithwaites), fully demonstrated its merits according to a plan which he patented on the 13th of July of that year,[2] and carried out successfully.

Captain Ericsson, 1836.

Instead, however, of launching to the public gaze a vessel on a large scale fitted with his plans, he made a model boat of about 20 inches in length, into which he placed a small engine, and floated her in a large bath over which a steam boiler had been fitted for the supply of hot water. From this boiler a pipe projected to within a foot of the water, where it was branched off by a swivel joint and connected with the engine in the boat. The steam when admitted put the engine in motion, and also the propeller, which at once sent the boat forward with considerable rapidity.

[1] "The Screw-Propeller: who Invented it?" by Robert Wilson, published by Thomas Murray and Son, Glasgow, 1860.

[2] See "Specifications relating to Marine Propulsion," Part II. pp. 127 and 128; *London Journal* (Newton's), p. 14, conjoined series, p. 34; *Mechanics' Magazine*, vol. xxvii. p. 130, vol. xxviii. p. 215, vol. xxix. pp. 143 and 283, and vol. xlii. p. 225; *Artizan*, vol. viii. pp. 187 and 209; also Bourne "On the Screw-Propeller," pp. 30 and 34.

Finding that his invention was likely to succeed when put into practical operation on a larger scale, Ericsson's next step was to order Mr. Gulliver, a boat-builder at Wapping, to construct for him a boat of wood which he named the *Francis B. Ogden*. She was 45 feet long and 8 feet wide, drawing 2 feet 3 inches of water. In this vessel he fitted his engine and two propellers, each of 5 feet 3 inches diameter. The result of her first trial went far beyond his most sanguine expectations. No sooner were the engines put at full speed, than she shot ahead at the rate of more than 10 miles an hour, and maintained that speed without a single alteration requiring to be made in her machinery;[1] nor were her capabilities as a tug less surprising. This miniature steamer, tested first by a schooner of 140 tons burden, towed her at the rate of 7 miles an hour during slack water on the Thames; and afterwards by the large American packet-ship *Toronto*, moving on with her astern at a speed of more than 5 miles an hour. The next experiment was made in the presence of the Lords of the Admiralty, who, accompanied by Sir William Symonds, Sir Edward Parry, and Captain Beaufort, had embarked in their barge to witness the novelty, and judge for themselves as to its efficiency and practical value. They were minute in their inspection, and as they did not, and in fact could not, offer any valid objections to his invention, Captain Ericsson felt confident that they would soon order the construction of a war-steamer on the new principle. In this, however, he was disappointed, though

The *Francis B. Ogden*.

[1] See Weale's Papers on "Engineering," vol. iii. Part V. pp. 1–7, "Steam Navigation."

though successful, fails to convince the Admiralty.

he had given them a very practical proof of its value by towing them in their barge at the rate of 10 miles an hour for a considerable distance—a speed which must have astonished their Lordships. The unseen and comparatively noiseless propeller, although it had furnished the most convincing proofs of its power, failed to propitiate their favour. Scientific theorists had informed the Board that the invention was constructed upon erroneous principles, and full of practical defects (one being that a ship thus propelled would be unsteerable), while engineers as a body regarded its failure as an event so certain as to preclude any speculations of its success. In a word, when publicly discussed, the general opinion was that the vast loss of mechanical power would prevent it from being employed as a substitute for the now old-fashioned paddle-wheel! [1]

Mr. T. P. Smith.

While Ericsson was making his experiments in the *Francis B. Ogden*, Mr. Thomas Pettit Smith, who, on the 31st of May, 1836, had taken out a

[1] With regard to the question of the progress of steam-ships in the Royal Navy since then, Mr. T. H. Farrer, of the Board of Trade, remarks, with great force, in a letter I recently received from him: "We hardly know how fast we move. One of my first colleagues at the Board of Trade, in 1850, was Admiral Beechey, an officer of very superior attainments and intelligence, and one who, having been much employed on surveys, was well acquainted with steam-vessels. And yet I well remember his telling me that he did not believe that the Navy of the future—the Royal Navy—ever could consist of steamers! Nor could he endure iron ships. It was a very few years after this that, in company with him, I witnessed one of the most beautiful sights of my life—the Naval Review at Spithead, in the first summer of the Russian war, when the last four or more sailing-vessels of the Royal Navy formed the attacking squadron. I shall never forget the beauty of the scene, when late in the afternoon these magnificent ships came on with a gentle breeze from the east, and the descending sun shed a 'dying glory' on their towers of canvas. It was a fit obsequy for the Hearts of Oak of Rodney, Howe, and Nelson."

patent for a "sort of screw or 'worm,' made to revolve rapidly under water in a recess or open space formed in that part of the after part of the vessel commonly called the dead rising or dead wood of the stern,"[1] was also at work with his invention, and, in the following year, put it into practical operation. His first trial, made in a small vessel of 6 tons burden, with an engine the cylinder of which was 6 inches diameter and 15 inches stroke, was considered by a few far-seeing persons so satisfactory,[2] that they applied for, and obtained on the 29th of July, 1839, an Act of Parliament for incorporating a company called the Steam Ship Propeller Company, to enable them to purchase "certain letters patent," that is, the screw-propeller of T. P. Smith.

The first successful application of this screw-propeller, on a large scale, was to a vessel called the *Archimedes*, constructed under the direction of the patentee of the screw, Mr. Smith. Her burden was 237 tons, and her mean draught of water 9 feet 4 inches; the diameter of the cylinder 37 inches, and the length of the stroke of the piston 3 feet; her screw-propeller consisted of two half threads of an 8 feet pitch, 5 feet 9 inches in diameter; each was 4 feet in length, and they were placed diametrically opposite to each other, at an angle of about 45 degrees on the propeller shaft. The propeller itself passed through a hole cut in the dead wood, immediately before the rudder; the keel being continued under the screw. The performance of the

The *Archimedes*.

[1] "Specifications relating to Marine Propulsion," Part II. p. 127.

[2] *Mechanics' Magazine*, vol. xxxi. p. 225.

engines averaged twenty-six strokes per minute, the revolutions of the screw at the same time being 138$\frac{2}{5}$. The calculations of the inventor were that, provided there was no slip or recession, the vessel ought to advance 8 feet for every revolution of the screw, or 12·60 miles per hour. But the utmost speed ever obtained by the *Archimedes*, under the power of steam alone, was 9·25 nautical miles per hour, showing a loss by recession of rather less than one-sixth under the most favourable circumstances. The *Archimedes* was not, however, a fair illustration of the screw-propelling principle, as her steam-power was not great enough to drive a screw sufficient for the size of the vessel. Nevertheless, in her subsequent trials from Dover to Calais against the *Widgeon*, the fastest paddle-steamer on the station, the superior value of the screw-propeller was proved. Although in the first three or four experiments the *Widgeon* had the advantage by a few minutes, in the subsequent trials, both vessels having set the whole of their sails, the *Archimedes*, carrying much more canvas than the *Widgeon*, on a run of 26 miles from Dover to Calais, close hauled, accomplished this distance in nine minutes less time than the *Widgeon*. Upon the return voyage to Dover, with a fresh breeze abeam and all sail set, the *Archimedes*, with a speed of ten knots per hour, performed the distance in five and a half minutes less time than the *Widgeon*.

Her trial with the *Widgeon*, Oct. 1839.

and its results.

These experiments decided the practical value of the screw. They proved that the *Archimedes* was slightly inferior to the *Widgeon* in light airs, in calms, and in smooth water; but, as the steam power of the

former was ten horses less, and her burthen 75 tons more than that of the *Widgeon*, it is evident that in *such* vessels the propelling power of the screw alone was equal, if not superior, to the ordinary paddle-wheel. In this respect, therefore, Mr. T. P. Smith's invention might be considered completely successful. It was evident from the second trial that, in steaming against even a light wind, the low masts and snug rig of the *Widgeon* gave her an advantage over the *Archimedes* with loftier masts and heavier rig; but, on the last two trials, the power of the sails operated favourably for the *Archimedes*, as she then beat the *Widgeon*, and made the passage between Dover and Calais in less time than it had ever previously been performed by any of Her Majesty's mail packets. On this occasion the *Archimedes* went from Dover to Calais in two hours and one minute, and returned in one hour and fifty-three and a half minutes.[1]

Although the successful performances of the *Archimedes* brought the screw into more general notice, it does not appear that she was ever employed as a trading vessel. After several experiments she lay for a long time in the East India Dock advertised for sale, and her spirited proprietors, who had been so instrumental in promoting the introduction of the

[1] The first experimental trip of the *Archimedes* was made on Monday, October 14th, 1839, the second on the following Wednesday, in the presence of Sir Edward Parry, Sir William Symonds, Captains Basil Hall, Austin, and Smith, R.N., and several civil engineers. Subsequently to the Admiralty trials between Dover and Calais, Captain Chappell, R.N., sailed round England and Scotland in her, calling at numerous ports; details of this voyage will be found in Appendix D to Tredgold "On the Steam Engine."

screw-propeller, lost all the capital they had invested in this important undertaking.

As the *Widgeon* and *Archimedes* differed materially in size and form, an exact comparison could not be made by them between the performance of the screw and that of the paddle; but the result of these trials nevertheless showed (especially when the peculiar fitness of the screw for war purposes was taken into consideration) the propriety of having a further and fairer trial of this novel instrument. With this object in view the *Rattler* was ordered to be built,[1] and, that the experiment might be conclusive so far as a trial could be made between two vessels, she was constructed on the same lines as the *Alecto* (her after part being lengthened for the insertion of the screw), and fitted with engines of the same power, and on a plan which had been previously tried with paddle-wheel vessels.

The *Rattler* and the *Alecto*, 1843.

The river trials of the *Rattler* lasted from October 1843 to the beginning of 1845, and showed that the screw-shaft might be advantageously reduced in diameter, and the blades by about one-third of their length, an alteration which greatly reduced the weight of the screw, and facilitated the operation of shipping and unshipping it, while rendering unnecessary the wounding to so great an extent of the after part of the vessel. Before, however, this last point

[1] The *Rattler* was launched from Sheerness Dockyard in April 1843. She was considered a remarkably fine model, and of very unusual length in proportion to her beam, her dimensions being 195 feet extreme length, close upon 33 feet extreme breadth, and 18½ mean depth of hold. Her burden was 888 tons. The log of this vessel from 28th of March to 13th April, 1851, will be found in the Appendix to a Report of a Committee of the House of Commons, 1851, p. 565, where the merits of the screw are examined.

was decided (it not being evident that the good performance of the shorter screw was not attributable to the greater clearance which the reduction of its length had caused), the screw aperture was partly filled up in a temporary manner, so as to leave the shorter screw the same clearance as the longer one had originally. The result of this experiment proved that the aperture in future vessels might be constructed of very moderate dimensions without lessening the propelling power of the screw.

The *Rattler* not as successful as expected.

These trials clearly showed that the screw, as an instrument of propulsion in smooth water, is not inferior to the paddle-wheel. But further experiments were considered necessary to establish its superiority in all respects. In the early part of the year 1845 the *Rattler* proceeded, in company with the *Victoria and Albert* and the *Black Eagle*, from Portsmouth to Pembroke. When rounding the Land's End, and steaming against a strong head wind, both these vessels, as might be expected, showed a great superiority, their power being much greater than the *Rattler's* in proportion to the resistance, and their paddle-floats being constructed on the feathering principle. This comparative failure of the *Rattler* left an unfavourable impression as to the efficiency of the screw against wind and sea in heavy weather, and this impression continued for several years, although when next tried in a run from the Thames to Leith, she showed in respect to speed a decided superiority over one of the paddle-wheel vessels employed in that trade, whose power as compared with her tonnage was greater than that of her competitor. Before joining the squadron under the command of Rear-

Admiral Hyde Parker in July 1845, the *Rattler* was employed to tow the *Erebus* and *Terror* to the Orkney Islands on their fatal expedition to the North Pole, and she seems to have performed that duty to the entire satisfaction of Sir John Franklin.

Captain Robert F. Stockton.

In following the progress of the screw as applicable to the propulsion of merchant vessels, and its use in other countries, I must now recur to the period when Ericsson was making his experiments on the Thames. At that time an intelligent gentleman, Captain Robert F. Stockton, of the United States Navy, was on a visit to London. Being of an inquisitive turn of mind, like most of his countrymen, and fond of scientific pursuits, he watched with great interest the trials with the screw then in progress, and having obtained an introduction to Ericsson, he accompanied him on one of his experimental expeditions on the Thames. Unlike the Lords of the British Admiralty, who allowed eight years to elapse before they built their first screw-propeller, the *Rattler*, Captain Stockton was so strongly impressed with the value and utility of the discovery, that, though he had made only a single trip in the *Francis B. Ogden*, and that merely from London Bridge to Greenwich, he there and then gave Ericsson a commission to build for him two boats for the United States, with steam machinery and propeller as proposed by him. Stockton, impressed with its practical utility for war purposes, was undismayed by the recorded opinions of scientific men, and formed his own judgment from what he himself witnessed. He, therefore, not only ordered the two iron boats on his own account, but at once brought the subject before

the Government of the United States, and caused various plans and models to be made at his own expense, explaining the peculiar fitness of the new invention for ships of war. So sanguine was he, indeed, of the great importance of this new mode of propulsion, and so determined that his views should be carried out, that he encouraged Ericsson to believe that the Government of the United States would test the propeller on a large scale; Ericsson, relying upon these promises, abandoned his professional engagements in England, and took his departure for the United States. But it was not until a change in the Federal administration, two years afterwards, that Captain Stockton was able to obtain a favourable hearing. Orders were then given to make the experiment in the *Princeton*, which was successful. The propeller, as applied to this war-vessel, was similar in construction to that of the *Francis B. Ogden*, as well in theory as in minute practical details.

efficiently supports Ericsson's views.

One of these boats, named, after her owner, the *Robert F. Stockton*, was built of iron by Messrs. Laird of Birkenhead, and launched in 1838. She was 70 feet in length, 10 feet wide, and drew 6 feet 9 inches of water. Her cylinders were 16 inches diameter with 18 inches stroke, and her propeller 6 feet 4 inches in length. On her trial trips on the Thames, made in January of the following year, she accomplished a distance of 9 miles (over the land) in 35 minutes with the tide, thereby proving the speed through the water to be between 11 and 12 miles an hour. On her second trial, between Southwark and Waterloo bridges, she took in tow four laden barges,

with upright sides and square ends, having a beam of 15 feet each, and drawing 4 feet 6 inches of water. One of these was lashed on each side, the other two being towed astern, and, though the weight of the whole must have been close upon 400 tons, and a considerable resistance was offered, also, by their form, the steamer towed them at the rate of $5\frac{1}{2}$ miles an hour in slack water, or in 11 minutes between the two bridges, a distance of 1 mile.

These experiments having been considered in every way satisfactory, the *Robert F. Stockton,* of which the following is an illustration, left England for the

United States in the beginning of April 1839, under the command of Captain Cram, of the American merchant service. Her crew consisted of four men and a boy, and, having accomplished the voyage under sail in forty days, Captain Cram was presented with the freedom of the city of New York for his daring in crossing the Atlantic in so small a craft, constructed only for river navigation.

In 1840, Captain Stockton sold this vessel to the Delaware and Rariton Canal Company, permission having been obtained (being British built) by a special Act of Congress, to run her in American waters, and her name was at the same time changed to that of the *New Jersey*. For many years she was in constant work as a steam-tug on the rivers Delaware and Schuylkill during the winter months, as she was capable of towing through the drift ice, where paddle-wheel steamers are of little use. His vessel a complete success;

If we except the small vessel tested by J. Stevens[1] between Hoboken and New York in 1804, the *New Jersey* was the first screw-propelled vessel practically used in America, numerous experiments with the screw having been previously made without success, and she certainly was the first used for commercial purposes. The importance of the screw as a propeller having now been fully admitted in America, 150 vessels of a similar description were in less than ten years from that time employed in the United States; most of which continued to be in active operation in the carrying trade, returning large profits to their owners, particularly those employed on the great North American Lakes. Indeed, in 1848, thirteen screw-propelled vessels were employed on Lake Ontario, and only nine paddle-wheel steamers. and the first "screw" used for commerce in America.

It is not my province to decide to whom the honour of the invention of the screw is due. It had engaged, as has been shown, the attention of various men in different countries for more than a century

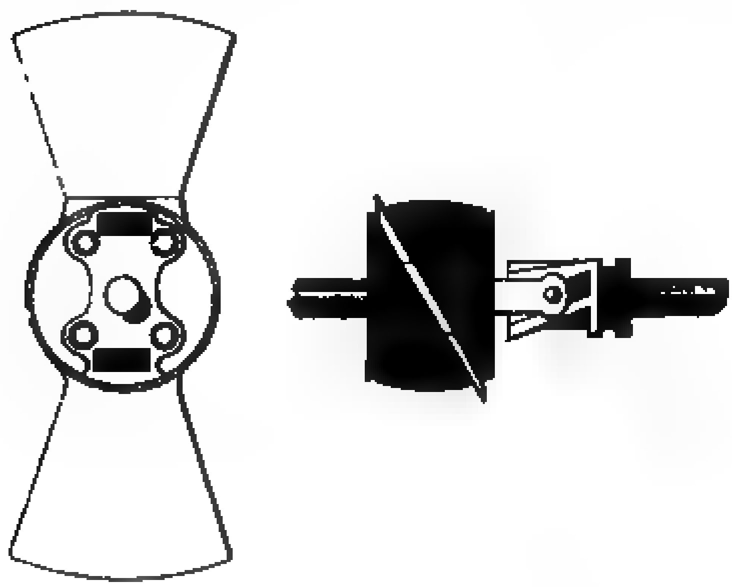
[1] The "screw" which Mr. Stevens used in his boat cannot have been of a practical character, or the Americans would not have allowed so valuable an invention to lie dormant for 35 years.

before it was applied to any useful purpose, and, like most other great inventions, has evidently been the production of many minds. I can, therefore, only deal with it as has been done in the case of the steam-engine itself, in its application to marine propulsion, by inquiring who it was that first, by practical tests, showed its superiority to the paddle-wheel, and that, for the purposes to which it has been applied, it could maintain such superiority over all other modes of propulsion. As this appears to me to be the only way in which this question can be fairly treated, I shall venture to state that, if Robert Fulton of America and Henry Bell of Glasgow are entitled, as I think they are, to be considered the first who put the paddle steamer into practical and *continuous* employment (I hold that James Watt and Robert Symington were its true inventors), it may, with equal justice, be said that to Captain Ericsson, Mr. Pettit Smith, and Mr. Woodcroft, the credit is chiefly due of having put the screw into working order so as to show how it could be profitably employed for the purposes of commerce or of the arts of war, though, at the time when Smith and Ericsson were practically illustrating the power of the screw, in their respective forms, that of Mr. Woodcroft, though well known, had not then been tried. In fact, his invention bears date antecedent to that of either of the others,[1] and proved equal, if not superior, when tested; indeed, it must have been

[1] Mr. Woodcroft patented, on the 18th of November, 1826, a mode "for propelling boats and vessels," but no specification was enrolled; and on the 22nd of March, 1832, he "prolonged" his patent "increasing-pitch screw-propeller," which he then fully described. (See Specifications of Marine Propulsion, Part XI. p. 112.)

considered so by the Admiralty, as it was fitted in the royal yacht *Fairy*, which, with the exception of the *Rattler*, and the *Bee*, of thirty tons, was the first screw-propeller in Her Majesty's Navy: it was also about the same time applied to H.M.S. *Dwarf*. Mr. Woodcroft's "varying-pitch screw-propeller," patented by him in February 1844, of which the following is an illustration, was, cer-

Superiority of Mr. Woodcroft's "varying-pitch" peller, 2.



tainly, in advance of any other at that time, and is, I believe, still considered the best and most useful type. In the account of it furnished by its able and ingenious inventor, it is said to be the "only propelling instrument of any description which has the peculiar and inherent property of acting with an increased impulse against the water from the leading part, first taking its action against the water to the end, however long or short such propeller may be upon its axis."

However, be that as it may, when an impartial review is taken of all the facts, it may be said of Messrs. Woodcroft, Ericsson and Smith that, while each may be regarded as the individual author of

their respective plans, conceiving as they did their designs apart from each other, we are indebted to them conjointly for this most valuable invention.

While the relative merits of the paddle-wheel and screw were being tested, the attention of scientific men was necessarily directed to the different forms of ships or lines best adapted to the various requirements of maritime commerce, which the introduction of steam had either created or materially developed. Vessels of every conceivable form, and of varied dimensions, have been in use from the earliest ages: we have had, of one sort or another, canoes, coracles, barges and yachts, coasters and Indiamen, with frigates and line-of-battle ships such as they were, almost from the dawn of history, and no doubt their owners and builders bestowed much thought and exercised considerable skill in their construction, so as to suit the varied purposes for which they were required; but it is only within our own time that a thorough scientific knowledge has been invited to aid in the construction of our merchant ships.

That knowledge has become much more necessary now than it ever was before. To construct an useful and first-class steam-vessel, we must first build a hull adapted to receive machinery, and then erect suitable engines and boilers with an appropriate propelling apparatus, combining the whole into a form such as will insure safety and speed, the requisite space for the crew, machinery, fuel, and stores, with accommodation for passengers and their numerous wants, and, also, sufficient space for a remunerative cargo.

To embrace to the utmost advantage these various

essential qualities in a merchant-vessel, the trade in which she is to be employed requires to be considered with her mercantile capabilities in relation to cost and speed. These calculations must be carefully gone into so as to obtain an approximate estimate of the commercial advantage with regard to the cost of freight per ton, that attends the employment of ships suitably constructed for the service in which they may be employed as compared with vessels of inferior adaptation. By this investigation, the comparative financial balance of outlay and expenditure and, consequently, the income to be expected from one vessel as compared with another, may be equitably apportioned. Such considerations as these are essential to success, and cannot be neglected by any shipowner who understands his business. They will not only conduce to an effective direction and management of mercantile shipping, and of financial economy, but, also, in case a vessel fails to fulfil an assigned service, the degree in which such failure may be attributable to faults of original construction (producing a low scale of locomotive efficiency), or to defective management or to imperfect navigation, may be determined. Moreover, steamship proprietors, especially, would thus be enabled to ascertain the relative value of their stock, not, indeed, as respects the intrinsic value of the respective ships, but as respects their relative working properties and consequent value for any special service. Each vessel might thus be assigned its most appropriate duty, and ships, manifestly unsuitable for one line of trade, might be otherwise employed or disposed of, instead of being put on services which they are *construc-*

In building fit vessels, the trade in which they are to be employed must be considered.

tively inadequate to perform. For example, a vessel may be well suited for the economical conveyance of cargo at eight miles an hour, but, being employed upon a service demanding a higher rate of speed, and failing to attain this, is held to be inefficient, while the value of the ship becomes unduly depreciated, and incapacity of *direction*, the real cause of the failure, escapes due observation.

CHAPTER III.

Steam-ships of the United States—Improvements in form of hull—Natural facilities for Steam Navigation in America—Her lakes—Canals—Harbours—Rivers—Seaboard—Bays and roadsteads—Rapid increase of steam-vessels—First vessels built for the western rivers and lakes—Dangers of River Navigation—Number of steamers lost by "snags," ice, fire, and collision, 1831–1833—Peculiar description of wharves and levees—Description of steamers employed—Boats of the Mississippi—Boatmen—Engines of the steamers—Different construction of the steamers on the Atlantic rivers—Great speed of American lake and river steamers—Peculiarity of construction—Steamer *New World*—Details of her construction—The *Daniel Drew*—Her enormous speed—Pacific Steam-ship Company started, 1847—Cost of establishing it—Speed of its vessels—Difficulties to encounter—Number of its steamers—Services performed—China and Japan line—"Law" line of steamers—South American Steam-ship Company—Mr. Randall's projected large American steamer—Details of proposed ship—Two sets of paddle-wheels—Principle of construction—Advantages to be derived from vessels thus built—Mr. Randall's experience of steamers employed on the lakes and the Pacific.

WHILE Great Britain is entitled to the credit of the invention of the marine steam-engine with its auxiliaries, the paddle-wheel and screw, and of having first put both into practical, if not in the earliest stages remunerative, operation, America may, on her part, justly claim the making of many improvements on them, and the turning the new motive power to profitable account with greater rapidity than England. Steam-ships of the United States.

To the Americans we owe the modification of Watt's engine still in use in their vessels: to them we are also indebted for engines of long stroke with the necessarily long crank, and the further peculiarity of upright guides for the piston-rod instead of the old parallel motion. They likewise first introduced the paddle-wheel with divided floats by which the resistance of the water was rendered more uniform, and the concussion of the common paddle-wheel avoided. But, above all, they were the first to improve the form of steam-vessels by substituting a fine entrance and a clean, clear run for the round or bluff bows and full sterns previously prevailing. By these important alterations, and by making the length of their vessels eight and, occasionally, ten times their beam, they succeeded, even during the infancy of marine steam propulsion, in raising the rate of progress from 9 to 13 miles an hour, and in giving to the world lines for the modelling of ships vastly superior to any hitherto adopted.

Improvements in the form of hull.

Natural facilities for steam navigation in America.

But nature has afforded our great Transatlantic rivals marvellous facilities for the development and rapid increase of vessels propelled by steam, not possessed by ourselves. The lakes[1] of America are,

[1] Lake Ontario, which lies nearest to the Atlantic, is 172 miles in length, about 60 miles in extreme breadth, and 483 miles in circumference. Lake Erie is about 265 miles in length, from 30 to 60 miles in breadth, and 529 miles in circumference; while Lake Huron is 240 miles long, from 186 to 220 miles wide, and 1000 miles in circumference. Michigan, which is connected with Lake Huron by a navigable strait, is 300 miles in length, 75 miles in width, and 920 miles in circumference, having a superficies of 16,200 square miles. But Lake Superior is the largest of all the lakes, being no less than 360 miles in length, and 140 miles in breadth, with a circumference of 1116 miles; the line of coast formed by the margins of these lakes extends to upwards of 4000 miles, while they are all, nearly throughout

in fact, extensive inland seas, affording in themselves an almost unlimited source of profitable employment to vessels propelled by steam. Their shores are lined with sheltered bays and natural harbours, with waters unusually free from rocks and shoals, while, in their immediate vicinity, are vast tracts of rich lands requiring only the industry of man to render them subservient to his wants, while the surrounding forests at the same time produce some of the finest pine timber in the world. Her lakes.

Great cities, such as Chicago,[1] Buffalo, Detroit, Michigan, Milwaukie, Toronto, and Kingston, besides numerous towns and villages, now line their banks, while those lakes which have no natural navigable communication with each other are now connected by means of canals, so that vessels from the Atlantic can penetrate for upwards of 2000 miles into the interior, in fact, to the most remote habitable regions of North America.[2] Short canals, also, overcome the natural obstacles presented to navigation by the rapids of the

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their entire length and breadth, navigable for vessels of the largest description, their depth varying, except within a short distance of the shores, from 12 to 200 fathoms.

[1] Chicago, situated on the south-west shore of Lake Michigan, at the mouth of a river of the same name, was in 1830 a mere station in the midst of a forest where a few Americans traded with the Indians in furs. Ten years afterwards it had 4470 inhabitants; but in 1850 these had increased to 27,620, and in 1853 to 60,552. In 1860, when I visited that place, it had become a great city, with somewhere about 150,000 inhabitants, numerous handsome stone buildings, and magnificent stores; those for grain capable of containing, according to the annual report of the Chicago Board of Trade, 5,475,000 bushels of corn, with a capacity for shipping no less than 1,835,000 bushels each day. Indeed, I witnessed the loading of a brigantine with 9000 bushels of wheat from one of these stores in two hours!

[2] The first vessel ever built on western waters was the brig *Dean*, launched at Alleghany City, Pa., in 1806.

St. Lawrence and the Falls of Niagara; and, while, on the one hand, the Erie canal of 363 miles in length connects that lake with the River Hudson, and consequently with the Atlantic Ocean, the Ohio Canal, 334 miles in length, on the other hand, brings it into connection with the Gulf of Mexico by way of the great rivers Ohio and Mississippi: thus, with the Welland Canal,[1] the connecting link between the other lakes and Ontario, there is navigable communication throughout the whole of the vast continent of North America, extending from the Gulf of St. Lawrence to the Gulf of Mexico, a distance of upwards of 3000 miles. All these lakes are now well supplied with lighthouses, buoys, and beacons to insure the safety of the large fleets of shipping employed on them. There are, also, numerous spacious harbours, many of them built of stone, as also breakwaters, the waves on these lakes during gales of wind being hardly less formidable to navigation than those of the ocean.

Canals.

Harbours.

Rivers.

But if the lakes of North America are vast in extent, the navigable rivers are even more gigantic, and afford still wider fields of remunerative employment for steamers.[2] Indeed, until steam-ships were

[1] In a letter I received, January 5th, 1855, from Mr. E. P. Dorr, the President of the Buffalo Board of Trade, he says: "The Welland Canal, as it now stands, is used almost wholly by American vessels. It is the key of the other canals; its length is 28 miles, and there are 28 locks, as Lake Erie is 256 feet above Lake Ontario: but a new and enlarged canal is in process of construction, which, when finished, will admit vessels of large tonnage."

[2] In 1860 there were 265 steam-vessels of 104,543 tons register, belonging to the United States, and 104 similar vessels, registering 33,269 tons, owned in Canada, all of which were engaged in the commerce of the lakes. On January 1st, 1875, the number of steamers

launched on their surface, many of these rivers were altogether unnavigable, and some of them unexplored. Those of my readers who have not visited America, can form only a very imperfect idea of her mighty streams. Some of them, as may be seen by reference to a map of the United States, have their source in the northern parts of the Rocky Mountains, and discharge themselves by the Gulf of St. Lawrence into the Atlantic, while others rising in the west of these mountain ranges flow into the Pacific. Those which have their sources to the east of the Alleghany Mountains find their way by various routes, and through luxuriant valleys, some of them of enormous extent, to numerous outlets on the shores of the Atlantic and on the north-eastern portion of the Gulf of Mexico, while the rivers comprehended under the head of the Mississippi and its tributaries, which spring from that great valley between the Alleghany and the Rocky Mountains, likewise pour their huge volumes of water into the Mexican Gulf, with New Orleans as the chief entrepôt of their now gigantic commerce. The former rivers, upwards of one hundred in number, afford an aggregate amount of more than 3000 miles of ship and boat navigation. But the latter, embracing the parent Mississippi, the Missouri, the Ohio, Arkansas, Red River, and various

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belonging to both countries, thus employed, had increased to 689, measuring 258,980 tons. They range in size from 250 to 1500 tons. But, besides these, there were 1770 sailing-vessels of 386,554 tons similarly engaged, or an aggregate of 645,534 tons, one in every five of which vessels can go through the Welland Canal, three-fourths of them being American and one-fourth Canadian. Some of the lake sailing-vessels occasionally trade to England, the first, the *Dean of Richmond*, having taken a cargo from Chicago direct to Liverpool in 1856.

other tributaries pouring their waters into the giant stream, constitute an aggregate length of no less than 44,000 miles![1] Large steamers now ascend to Pittsburg, a distance of 2000 miles from the Gulf of Mexico. The Missouri, which joins the Mississippi 18 miles above the city of St. Louis and about 1200 miles from the gulf, has an uninterrupted navigation of 2532 miles from its mouth; its tributaries being the Gasconade, navigable for 150 miles; the Osage for 500 miles; the Chariton for 300 miles; the Tansas for 200 miles; and the Yellowstone for 800 miles; while the Moine, which flows into the Mississippi 130 miles above the Missouri, is supposed, with its tributaries, to be navigable for a distance of 1500 miles.

Such are a few, but a few only, of the many navigable rivers which pour their waters into the Mississippi; there are many others whose names our space precludes the possibility of our even mentioning. To the north and the west, we have the St. Lawrence, a river second only to the Mississippi, with a course of upwards of 2000 miles, receiving the waters of about thirty others of considerable size; and, though navigable itself for large sea-going vessels only as far as Montreal, a distance of 880 miles from the Atlantic, it is extensively used in its upper portion under the name of the St. Mary's River, where, among the islands with which it is studded and the numerous rapids with which it is impeded, it is navigated by vast rafts of timber and by fleets of strong flat-bottomed boats expressly built

[1] "Civil Engineering of North America," pp. 60, 61.

for the purpose, and well-known as the Canadian *batteaux*.

Then we have the River Hudson (on which the first vessel in America propelled by steam was employed), small in itself compared to those I have named, but important from its connection with New York, and the extent and value of its trade; and most interesting to the traveller, from its beautiful scenery. This river is navigable for ships of large burden up to the town from which it derives its name, about 120 miles above New York, and for vessels of smaller draught of water to Albany and Troy respectively 30 and 34 miles further. To the north we have the Penobscot with a course of 300 miles from the bay of that name in the State of Maine, navigable for large vessels to Bangor, a distance of 50 miles, and the Kennebach River with a course of 230 miles, navigable for 40 miles from the sea, as also the Merrimac of 200 miles in length, and the Connecticut, which, after a course of 450 miles through a highly cultivated and fertile country, discharges itself into Long Island Sound.

To the south there is the important River Delaware, of 310 miles in length, navigable for vessels of the largest class to Philadelphia, a distance of 40 miles, and the Susquehanna flowing into the Chesapeake, which, though the largest river in the important and productive State of Pennsylvania, is more celebrated for the beauty of its scenery than for the facilities it affords for navigation. There is also the Patapsco, navigable to Baltimore for vessels drawing 18 to 20 feet of water; the Patuscent, navigable for 60

miles from its mouth; and the Potomac, navigated by vessels of the largest class to Washington, a distance of 103 miles from Chesapeake Bay; as also the Rappahannoc, navigable for 110 miles to the town of Fredericksburg, besides the James River and various others of greater or less importance extending along the line of coast from Chesapeake Bay to the western shores of the Gulf of Mexico.

Seaboard.

But, beyond the vast facilities these immense lakes and rivers afford to a maritime commerce capable of development to an extent far beyond the conception of the most sanguine enthusiast, there is the extensive seaboard of that great continent, studded with harbours, and containing some of the most magnificent bays and the largest and safest roadsteads to be found in any part of the world. Take, for instance, the line of coast extending northwards from Chesapeake Bay to the Gulf of St. Lawrence: that bay, itself, has safe anchorage for an untold number of vessels; and, to the northward, there are numerous other bays and sheltered sounds, affording natural facilities for the formation of harbours more commodious than any which works of art alone, however costly, could possibly supply. From among these the Americans have been able to select many admirable sites for their trade emporiums,—in themselves also natural harbours of refuge of the finest description, completely sheltered from the surge of the ocean, and, therefore, not requiring for their protection the expensive breakwaters of Plymouth, Portland, or Cherbourg; where, along

Bays and roadsteads.

the margin of projecting tongues of land or within out-lying islands, vessels of the largest description can anchor in safety, or be moored alongside jetties erected at a trifling expense, where, too, they can discharge their cargoes into warehouses with almost as much ease as they could do in the London or Liverpool docks. These natural advantages, amply illustrated as they are in the case of New York, a city evidently destined to rival, if not to surpass, any city of either ancient or modern times, London not excepted, struck the writer with surprise and wonder. Situated on the southern portion of the island of Manhattan, New York is washed on the east by the sound separating it from Long Island,[1] and on the west by the estuary of the River Hudson, while the bay itself, which is nine miles in length and five miles in breadth, has a communication with the Atlantic through a strait two miles in width, between Staten Island and Long Island, completely sheltered from the ocean and forming a magnificent deep-water basin, with abundant quays and jetties on its eastern, western, and southern margins: here vessels of any size can deliver their cargoes into the heart of the city at all times and in perfect safety.

Proceeding further north we reach Boston Bay, more celebrated than any other place in the history of the War of Independence, a thoroughly sheltered inlet of about 75 square miles in extent, inclosed by two necks of land so nearly approaching each other as to leave only a narrow entrance communicating directly with the Atlantic, with deep water

[1] Long Island Sound lies between that island and the mainland, and extends in a north-easterly direction from New York Harbour, affording a sheltered line of navigation of about 120 miles in extent.

close in shore where numerous wharves are erected as in the case of New York. Further north, we reach Narraganset Bay, and, within it, the town of Newport and its finely sheltered roadstead forming one of the most superb natural harbours in America; also Penobscot Bay into which the river of that name flows, and Passamaquoddy with its excellent roadstead receiving the waters of the River St. Croix, the boundary between the United States and the Dominion of Canada.

With such magnificent bays, harbours, roadsteads, lakes, and rivers all ready formed by the hand of Nature to receive an almost unlimited extent of shipping, and, at the same time, peculiarly adapted for the employment of steamers, it is not a matter for surprise that the Americans should have directed their genius and energy to this new branch of industry and their skill to the rapid development of the power of steam, affording them as it did extraordinary means of opening out hitherto unknown branches of commerce and new sources of almost unbounded wealth. More conversant at this period than any other nation with the most approved style of shipbuilding, and possessing an abundant supply of materials at a comparatively low price, they were able, when steam-vessels were first introduced, to construct them at a lower cost than any other people; and if they had not the same facilities for obtaining steam-engines, these could easily be obtained from England.

From the time therefore that Fulton [1] launched the

[1] If any further proofs were necessary to show that almost everything done in this new business had its origin in England, these will

Clermont at New York, and proved, by her performance in 1808 on the Hudson, that vessels propelled by steam could be made a source of profitable employment, they were increased with a rapidity and employed to an extent, especially during the first quarter of this century, far in excess of Great Britain. Besides the *Clermont*, launched in 1807, Mr. Charles Brown an enterprising shipbuilder of New York, built in that year, also for the navigation of the Hudson, the *Car of Neptune* of 295 tons, and the Raritan *Rareton*, of 120 tons, named after the river on which she was employed. In 1811, he launched the *Paragon*, of 331 tons, which was likewise employed on the Hudson, and, in 1812, the *Firefly*, to trade between New York and Newburg, as well as the *Jersey*, ferry-boat of 118 tons, employed in the same year by the Ferry Company for the conveyance of passengers between New Jersey and the city of New York.

Rapid increase of steam-vessels.

In 1814 the Americans launched their first steamship on the great waters of the Mississippi, at once showing the practicability of ascending that mighty river by accomplishing on her trial trip, immedi-

First vessels built for the western rivers and lakes.

be found in the fact, that a boat launched by Fulton on July 4th, 1815, was a counterpart of the one belonging to Mr. Miller, which he had seen on Dalwinston Lock some years previously. She was a structure resting upon two boats, separated from end to end by a channel 15 feet wide and 60 feet long. One boat contained the copper cauldrons, for preparing the steam; the other, the iron cylinder, piston, levers and wheels. The water-wheel revolved in a space between them just as in one of Mr. Miller's boats. Had Fulton, in this matter, claimed originality, it would, certainly, be another and striking instance of two persons resident far apart from each other, carrying out the same idea, even in its most minute details.

ately after she was built, a distance of 700 miles against the current. In 1818, they started a steam-boat to ply between New York and New Orleans, and, from that time, vessels of this description, steadily, and we may say rapidly, increased on their coasts and rivers. Their first steamer on the lakes was the *Orleans*, a two-masted vessel built at Pittsburg in 1811, but some time elapsed before any other steamer appeared on the Lakes, their then limited trade offering little inducement for profitable employment; hence, when the *Walk-in-the-Water*—a most characteristic name—commenced to trade on Lake Erie in 1819, there was no one to furnish her with a cargo except the American Fur Company. In 1827, the waters of Lake Michigan were first ploughed by steam, a boat having made an excursion to Green Bay, and in 1832, another steam-boat reached Chicago with troops, that site being then in course of clearance and settlement: in the following year, there were eleven boats on the lakes at a cost of 360,000 dollars, carrying in that year (1833) 61,480 passengers, and earning in freight 229,211 dollars. In 1834, seven new boats were launched, making eighteen in this service during that year; and in 1840, the number of boats trading between Buffalo, Chicago and other ports west of Detroit, their trip between these two places occupying fifteen days, had increased to forty-eight. Such was the beginning of the steam-boat traffic on the great North American lakes.[1] In the following wood-

[1] See *Western States and Buffalo Advertiser*, quoted by Mr. John MacGregor in his "Statistics of the American Lake Trade," London, 1847.

cut may be seen a fair illustration of one of these early vessels.

But it was on the rivers and along the sheltered bays on the coast that the new mode of propulsion made at first the most rapid progress. From the time when the pioneer boat ascended the Mississippi, steam-ships rapidly increased in number and in size, as well as in the power of their engines, so that, so early as 1832, there were no less than 900 arrivals of steamers at New Orleans from the upper country, and in 1834, there were 234 steam-vessels running on the Mississippi and Ohio, the large majority of which were built at Pittsburg and Cincinnati.

Dangers of river navigation.

The navigation, however, of these great rivers was for many years attended with almost endless difficulties and dangers. In the Ohio and other western waters of the United States, though the current does not average more than three miles an hour, there were rapids where, in some instances, it attains a velocity of from seven to eight miles. There were also numerous sandbanks, most of which

have now been removed, whereon the boats frequently took the ground and were detained until the next rise of water, sometimes for even three and four months. In the upper waters, too, the floating ice during the spring of the year occasioned many disasters, and is still a danger not to be prevented. But the greatest danger arose from what was known as "snags," stumps of trees which, from the falling in of the banks, are carried down the river until they lodge, with one end resting in the mud or sand, and the other rising to the surface sometimes so concealed as to baffle the utmost precaution in avoiding it. Among the sixty-six boats lost in the navigation of these western rivers during the years 1831–2–3, while seven were wrecked by ice, fifteen stranded and abandoned, fifteen destroyed by fire, and five wrecked by collision with other boats, no less than twenty-four were "*snagged.*"

Number of steamers lost by "snags," ice, fire, and collision, 1831–1833.

But, besides the "snags," there are dangers, though of somewhat less importance, arising from other falling trees, known by the name of "sawyers," trees which have sunk with an inclination down the stream, the action of the current upon them causing a continual vertical vibration, whence their name. Generally, when a boat going down stream strikes a sawyer, she will pass over it with little or no injury as its inclination is in the direction of the boat's movement. But the danger, here, differs from that of the "snags." Their inclination is up the river, their ends sometimes projecting above the surface at low water, or when the river is at a higher stage, remaining just sufficiently beneath the surface to be still more dangerous. Boats going down stream,

therefore, encounter very great peril, and it has frequently occurred that, when the "snag" lies at a great inclination, the end rises when struck and not only pierces the hull but passes up through all the decks.

These dangers are increased by the remarkable fluctuation in the depth of the water in the rivers, which is sometimes so great, as to admit the navigation of the largest vessel, and again so small, as to render it impossible to construct vessels with draught of sufficient lightness to float upon them.

On the Ohio, the rapids are chiefly caused by bars, or as they are termed "chains of rock," extending across the river, which, when the water is low, impede navigation and sometimes stop it altogether. Artificial means have, however, in some instances been adopted whereby a greatly increased volume of water is thrown into a single channel, but hitherto these schemes have not been of much practical utility, though the money expended in the removal of "snags" and other temporary obstructions has tended to render the navigation of the Ohio, as well as of the Mississippi, Missouri, and Red River, comparatively safe and easy to what it was when steam-boats were for the first time despatched upon these mighty streams.

Peculiar description of wharves and levees.

In consequence of the great fluctuations in the depth of the western rivers, no regular wharves or jetties can be formed alongside of which the boats engaged in the traffic can land their passengers and goods. In lieu of these, therefore, the banks of the river opposite to the towns, or where landing-places are necessary, are sloped off at a considerable

inclination and paved with ordinary paving-stones. At intervals along the shore, and, also, at different distances up the bank, piles are driven with large ringbolts attached to their heads for the purpose of mooring the boats. Owing, also, to the same cause, and the ever varying strength of the currents of the rivers, it is necessary that the boats employed on them should be as light as possible combined with the requisite strength, of small draught of water, and of great power, so as to be able to pass over the sandbanks and make headway against the currents.

Description of steamers employed.

In order that the boats may land passengers without difficulty at these sloping banks or "levees," as they are termed, and also discharge and take in freight and passengers, their bows have a very long rake, so that when they strike the bank the bow gradually rises out of the water till it has sufficient hold upon the bank to maintain its position while landing the cargo, without any material assistance from the warps attached to the mooring post. To facilitate the operation of landing, the forecastle deck carries its width in most cases right to the stem, so as to furnish the necessary platform for discharging and loading cargo. In order, also, to meet the frequent occurrence of very shallow water during the summer months, a class of boats has been constructed termed light-water steamers. They differ from the ordinary description of boats, in that they are built in the lightest possible manner and with a comparatively small engine power, so that their speed seldom exceeds from 6 to 7 miles per hour; they have, however, the advantage of being able to navigate rivers the ordinary boat could not traverse, their draught of water

ranging from 12 to not more than 18 inches when laden with cargo and passengers.

The vessels employed on the Mississippi vary in size from 150 to 1500 tons burden, and in some cases more. It is necessary, too, that these should be built so to draw as little water as possible, the largest not exceeding when loaded from 7 to 8 feet, as this great river is also impeded by bars or "chains" extending across it, though not to the same extent as the Ohio and other smaller rivers. At New Orleans, the *levee* or quay is from four to five miles in extent, with an average breadth of 100 feet. It is 15 feet above low-water mark, or that condition of the river when its waters retire within their natural bed, and is 6 feet above the level of the city, to which it is graduated by an easy descent. It is constructed of the alluvial soil brought down from the north, and deposited in the vicinity by the waters of the Mississippi.

Boats of the Mississippi.

Prior to the general introduction of steam navigation, the trade carried on by flat boats occupied a great space in this now important emporium of commerce. Hundreds of long, narrow, black, dirty-looking, crocodile-like craft lay sluggishly without moorings, upon the soft *batture*,[1]—a heterogeneous compound produced from the territories of the Upper Mississippi and its numerous tributaries, while they poured out their contents upon the quay. These rafts, or flat boats as they are technically called, which frequently had on board cargo to the value

[1] *Batture* is the original French word, still retained, applied to the new formation of alluvial soil formed by the capricious action of the Mississippi. The Levee extends from 43 miles below the city to 120 miles above it.

of from 3000*l.* to 5000*l.*, are covered with a raised work or scantling, giving them the appearance of long, narrow cabins, built for the purpose of habitation, but really designed to protect their contents from the weather. They are guided by an oar at the stern, aided with an occasional dip of two huge pieces of timber, which move on each side like fins (rude imitations of the leeboards to be found in Dutch galiots or Thames barges), and float with the stream at the rate of 3 miles the hour. Such were the means of carriage of the up-country's products on the Mississippi about half a century ago, and steam-boat navigation has not diminished the number of these flat boats. They are so natural, simple, and cheap a mode of transporting produce down the stream, that as long as the Mississippi passes with such rapidity from its source to its embouchure in the gulf, the traveller will be sure to meet with these unsightly masses floating on its bosom; swayed to and fro by its currents, counter-currents, and eddies, often shifting end for end like some species of shell-fish, and not unfrequently resembling the crab, preferring the oblique to the forward movement.

Boatmen. Like the boatmen of the Nile, the men who make these wooden habitations their usual dwellings are a distinct class. Launching their boats upon the Ohio, the Illinois, the Upper Mississippi, the Missouri, the Arkansas, and the Cumberland with all their respective tributaries, and guiding them to their final resting-place at New Orleans, these men are all known by the general designation of "Boatmen of the Mississippi." They are a strong, hardy, rough, uncouth people, with a touch of the savage about them.

Although the condensing engine is met with in some of the Mississippi steamers, high pressure engines are much more frequent, the pressure in the former being never less than 10 and frequently as high as 30 pounds to the square inch; when, however, this pressure is so worked, the object is to shut off the steam and take advantage of the expansion. In high pressure engines the pressure is used *ad libitum* from 50 to 150 pounds, and, in former times, to such an extent, that no mortal was left to measure its height, the boiler as well as the boat and its contents, animate and inanimate, having too frequently been blown into the air. In condensing engines, when moving at full speed, the steam is never "wire-drawn," as the engineers term it, the passages being made large enough, and the valves fully opened: the same, in high pressure engines: but, when not moving at full speed, the steam can be "wire-drawn" as the engineer thinks necessary. **Engines.**

The term "high pressure" in America is applied to that description of engine which is worked against the atmosphere or without condensation; all condensing engines are called low pressure. In both these engines ashwood and pine, where coal could not be easily obtained, were the descriptions of wood most commonly used for fuel,[1] and, in the dangerous

[1] In an address by Mr. Lothian Bell (May 1875), late President of the Iron and Steel Institute of Great Britain, the area of pit coal in the United States is computed at 192,000 square miles, as compared with 8000 square miles in the United Kingdom. Hitherto the expense of working any portion of these vast coal fields was too great to make it remunerative, but, now, the use of coals is being so rapidly substituted for wood in the American steamers that the facilities for working the mines and transporting the coals has marvellously increased within the last twenty years. Mr. Bell remarks, in the same address, that 20,000 tons of coal are sometimes embarked at Pittsburg on a flotilla of flat bottomed boats towed by one steamer and conveyed 1600 miles down

competition, happily less frequent now than it was some years ago, barrels of pitch, rosin, and even tallow were sometimes thrown into the furnaces, the recklessness of the captains and engineers on the Mississippi in working their boilers at a greater pressure than they could with safety carry, and, thereby, causing the frightful explosions to which I have just referred.[1]

Different construction of the steamers on the Atlantic rivers.

The steam-boats on the Atlantic rivers are differently constructed from those of the west, as the same necessity for light draught of water does not exist, while they are more especially intended for passengers; their cabins are, frequently, under deck, while those on the western rivers, constructed for carrying heavy cargoes as well as passengers, have their cabins, generally, in two tiers above the deck, hence the preference given to high pressure engines from their being lighter and occupying less space. The condensing or low pressure engine is much more prevalent in the Eastern boats, and is more economical in fuel than the high pressure: their boilers are usually circular; there is great variety in the form and construction of the furnaces and flues, and the boilers designed for burning wood

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the Ohio at something under a shilling a ton, including the cost of bringing back the empty barges.

[1] Between 1816 and 1848 no less than 233 steam-boats employed on American waters exploded, some of them involving terrible disasters, the lowest number during that period being one annually, but sometimes there were as many as ten, twelve, and thirteen in the course of a year. The loss of life in each accident averaged eleven persons, being a total of 2563 human beings killed, besides 2097 persons wounded. In one terrible explosion, that of the *Louisiana*, on the New Orleans *levee*, nearly 200 persons lost their lives. See *St. Louis Republican and Insurance Reporter* (U. S. A.).

are, of necessity, of greater external dimensions than those designed for burning coal, although the proportions of steam space may be smaller in the former than in the latter. These boilers are frequently worked at 18 to 20 pounds on the square inch, but 12 pounds is considered the medium.

The expansive action of the superheated steam in these engines, the greater space allowed for the engines to work in, and the generally admirable form of the boats, will, of course, tend to reduce the quantity of fuel required. The stroke of the piston, in some of the fastest American boats, is as much as 10 or 11 feet, and the connecting rods 13 to 19 feet long: the engine is worked at a much quicker rate than in England, the piston passing through the space of 500 feet in a minute, at which speed the whole machinery is found to work more smoothly than at a slower rate. It has been remarked by competent judges that, though the English engine is more perfect and more highly finished than the American, the advantage of superior workmanship is more than compensated in the American by greater length of stroke and the connection. American engineers consider the English engine, as applied to marine purposes, too confined, and until steam of a higher pressure is used, the boat must be of inferior speed to those of the United States. A Boulton and Watt engine[1] of 30-inch cylinder and 4-foot stroke, making twenty-five revolutions in a minute with 3½ pounds of steam, is estimated as a 30-horse engine; but the force of this engine, it is argued

[1] In the rule for nominal horse-power, Watt assumed 7 lbs. of steam as a mean pressure.

by Americans, will be increased one-third if steam of 7 pounds be used; "lengthen the cylinder," they remark, to 8 feet and drive the piston through that space in the same time, that is, 400 feet instead of 200, use the same quantity of steam by shutting it off at half the stroke, and the American engine as compared with the English will be nearly an 80-horse instead of a 30-horse power.

Great speed of American lake and river steamers.

In their early career the Americans were likewise much in advance, as we have seen, of Great Britain in the model and speed of their river steamers, a superiority they still maintain. Indeed, the competition on their rivers, especially on the Hudson, was then much greater than it is even now. This strong rivalry made speed of the utmost importance, as the boat which performed the trip between New York and Albany in the shortest time, if only by half an hour (the Americans not concerning themselves about the chance of an explosion), would be sure to take all the passengers. Hence every expedient ingenuity could devise was resorted to for this object, and to the skill and perseverance of Mr. Robert L. Stevens the Americans are greatly indebted for the perfection to which the models of their river boats have advanced. These boats were built on the finest models; their entrance and runs sharper than had ever been before attempted; besides this, he had several of the earlier ones sawn in two and their length increased 25 or 30 feet, at the same time carrying a false bow from 18 to 20 feet beyond the stem, and forming true lines with the planking of the boat. This experiment fully answered his expectations; their speed was surprisingly increased,

and, when running at the rate of 18 miles an hour, "they hardly raised a feather in front." But, in 1834, another American shipbuilder constructed a steamer 185 feet long and 20 feet beam, with solid ends sharper than any of the false bows, having a flat floor and a single-cylinder engine of 52-inch diameter and 10-feet stroke, which was pronounced to be "*the fastest thing afloat:*" indeed, to such perfection have these steamers been brought that they now traverse rivers once thought to be altogether unnavigable. The first attempt to reach the falls of the Ohio from New Orleans was considered so visionary that the projector was looked upon as little better than a madman, but steamers are now engaged in regular traffic wherever the bars are covered with 12 or 15 inches of water, American genius, skill, and perseverance having triumphed over almost every impediment.

Peculiarity of construction.

Each successive year new vessels have been built, surpassing their predecessors in their size and power and in the splendour of their decorations, while they possess every improvement the skill, taste, and experience of their constructor can devise. There exists, nevertheless, in the general external appearance of the boats employed on the river navigation a great similarity which may be seen also in the details of their construction and in that of their machinery, as well as to some extent in their models, their usual features being great proportion of length to beam, a shallow hold, and a long flat floor, extending almost to the extremities of the boat. Great buoyancy, and consequently, a very light draught of water are by these means secured, and as the shallowness of the

rivers in some places requires this, experience has demonstrated the advantage of attempting to go over rather than through the water when it is desirable to attain very high speed.

Although the absolutely best form of model and that which, under all circumstances, is subject to the least average resistance remains a matter of speculation, every builder having an opinion and theory of his own differing more or less from those entertained by his brethren of the craft, the competition and rivalry between the different builders and owners have been productive of extraordinary results. On the American rivers a sustained average speed of 20 miles per hour is now not an uncommon performance, due, doubtless, in part, to the improved form and fineness of the water lines, and, in part, also, to the great size and power of recent engines: add to this, that, from the superior tenacity and strength of American iron, the constructor is able to give his engines proportions considerably lighter than would be deemed safe elsewhere. The immense diameter of their paddle-wheels is also worthy of note as an element of no mean importance in the economical expenditure of the power developed in the engine and, consequently, in its effect on the speed of the boat. Taken as a whole, therefore, it would be impossible to find anywhere else finer specimens of naval architecture or more suitable engines for the special traffic on which they are engaged, than the boats now traversing the coasts, rivers, and lakes of the United States.

The steamers at present engaged in passenger traffic between New York and Boston, are magni-

HUDSON RIVER STEAMER "NEW WORLD."

ficent vessels; they are indeed "floating palaces;" and it is a fine sight to witness their departure every evening from New York. They run in connection with the railway at Allen Point, their course being about 140 miles by the East River and Long Island Sound, a distance generally accomplished in about seven hours and a half, including the delay in calling at New London.[2] Yet these magnificent vessels were (if they are not now) surpassed in speed by the steamers on the River Hudson, while they were equalled in the beauty of their lines and the splendour of their accommodation. An illustration of one of these, the *New World*, will be found on the preceding page.

Steamer *New World.*

This graceful and magnificent vessel is 380 feet in length. Her breadth of beam is 50 feet, or 85 feet over all, including the sponsons and paddle-boxes, while the diameter of her paddle-wheel is no less than 45 feet, and that of her cylinder 76 inches, the length of stroke being 15 feet. The *New World* has 347 state rooms or cabins, and 600 sleeping-berths. In her construction and equipment may be traced, to the most minute details, the natural mechanical ingenuity so characteristic of the Americans: every corner that would otherwise be vacant is adapted either to the necessities of the trade or to the comfort of the passengers. From the colossal beam engine with which she is propelled, down to the minutest fittings of her saloons, cabins, restaurant, bar, lavatories, smoking-room, and barber's shop,

[1] I am enabled through the courtesy of Mr. James Webb, the well-known ship-builder of New York, to furnish in the Appendix No. 6, p. 600, a description of the engines of the *Bristol* and *Providence*, the two finest steamers at present (1875) employed on the line between New York and Boston.

[2] No stop at New London now. The Norwich line covers this. Fall River boats are still I believe the finest of their kind.

there is, combined with the system and order generally prevalent, almost everything to admire and nothing the most fastidious could honestly condemn.

No doubt much of this perfection arises from the complete subdivision of labour to be found throughout most of the great American establishments, so apparent in many of their manufactories and workshops and in their large hotels as well as in their ships, but, more especially, in their river and coasting steamers. For instance, the construction, fitting, and equipment of the latter is carried on throughout by a class of people who devote themselves entirely to such work, and make it a study to attain perfection in it. Whatever may be the case in the "Far West," where labour is scarce, and, whatever may be the facility with which the Americans can adapt themselves to circumstances (developed as this was remarkably during the late civil war), a "Jack of all Trades" receives no encouragement in the equipment or in the manning of their steamers. Their shipowners require, in both cases, if they can be obtained, regardless of cost, men who thoroughly understand their respective duties, and in this, as well as in various other matters, England has much to learn from the Americans.

In the *New World*, we have an excellent specimen of the first-class American coast or river steamer, combining the multifarious and, apparently, conflicting requisites for vessels thus employed. With a light draught of water, such vessels require to have stability to carry in safety the lofty hotels erected on their decks, and to afford the spacious and sumptuous accommodation which competition has led every

American traveller to expect. High speed must also be combined with safety and comfort, and lightness blended with strength. To attain the former, the boilers of these vessels are placed outside the ordinary line of the hull of the vessel on guards or framework, an extraordinary position for heavy weights, but tending, materially, to safety in the event of explosion, and, to comfort, in causing less vibration and greater coolness, the furnaces being thus away from the cabins. To secure the latter, the rigidity of the hull is maintained by a perfect system of trussing with wooden beams, braces, iron tie-rods, and stays, together with innumerable other remarkable contrivances wherein great skill and scientific knowledge is displayed. By these and other contrivances, the requisite strength, combined with the greatest lightness consistent with safety, is ensured, so that the whole vast and commodious structure, with its towering cabins, lofty saloons, handsome galleries, balconies, and extensive promenades, fragile as they doubtless appear, is a marvel of mechanical skill, and, really, possesses much greater stability and power of resistance than is to be found in numerous vessels of other countries of twice the weight of materials used in the construction of the *New World*.

Details of her construction. The mode of constructing these vessels is entirely different to that adopted in any other country: thus, the hull of the *New World* is of wood, the external planking being about $3\frac{1}{2}$ inches in thickness, and the ribs sheathed internally for a considerable distance amidships by double-crossed diagonal woodwork. Further forward and aft, it is single, and, towards the end, there is no sheathing; but the floor-

timbers are strengthened by several longitudinal timbers or keelsons of considerable size.

To compensate for the want of depth in the sides of the boat, a "hog-back" or "bow" frame, consisting of timbers joined together in the shape of a bow, springing from the side at some little distance from the end of the boat, and rising to a height of 20 or 25 feet at the centre, is applied to strengthen it. This "hog-back" is braced to the side in several places by vertical and diagonal timbers and bolts, the whole forming a powerful trussed framework, placed directly over the side of the boat so as to be regarded as virtually an addition to the depth of the side. The floor of the boat is strengthened by a system of bracing consisting of masts 40 or 50 feet in length, which are stepped into the keelson and furnished at their top with caps to which are fastened iron rods; these rods radiate to the sides of the boat, like the shrouds of a ship, and thus transfer the upward pressure on the centre of the floor directly to the side. The deck beams project over the sides of the boat to the extreme width of the paddlebox-houses, constituting what are called the "guards." These guards are supported by diagonal struts underneath them, and they overhang to the extent of 18 or 20 feet at the centre, meeting in a point at the bow, but at the stern projecting about 2 feet 6 inches, so as to form a gangway round the ladies' saloon. But the success now almost invariably attending the construction of all the lake, coasting, and river steamers of the United States is attributable less to any theoretical inquiries and deductions than to a long course of practical experience,

or, as it has been characteristically termed, to "a course of trial and error." To show that this experience has been successful it is enough to observe that the steamers built for these waters carry a greater amount of freight, and accommodate a larger number of passengers on a given draught of water than those constructed in any other part of the world.

The *Daniel Drew.*

Although the *New World* was one of the largest and most magnificent vessels employed on the Hudson, she was surpassed in speed by the *Daniel Drew*, which has attained the extraordinary rate of 25 statute miles an hour without assistance from either wind or tide. From my own knowledge, I can confirm the accuracy of this statement, having made a passage in her from New York to Albany. To persons who, like myself, familiar with nautical affairs, have made their study the business as well as the pleasure of life, no more enjoyable sensation could have been afforded than the rapid movement of this vessel. Like some "thing of life" she noiselessly cut through the water with no curling wave or struggling foam at her bows, throwing aside only a silvery jet of the fluid over which she appeared to skim. Nor was the action of her machinery less worthy of admiration. After the first half-dozen strokes of the paddle-wheels when started, their pace was so smooth and rapid that sound and vibration alike were hardly perceptible.

Her enormous speed.

But, though the Americans have surpassed all other nations in the steamers hitherto produced for their lake and river navigation, they have not as yet sent forth any steam-ships so well adapted for ocean navigation as those of Great Britain; indeed, almost every attempt made by them to compete successfully

with British vessels so engaged has been a commercial failure. In their distant coasting lines (what a misnomer to describe the voyage between New York and San Francisco as "coasting trade"!) they have, however, for many years employed some of the finest steam-ships afloat. In fact, when the district of California was almost a wilderness, the merchants of New York started a line of steamers to trade with it, and were thus, in a great measure, the means, though at a heavy loss to themselves, of developing its marvellous natural resources.

The Pacific Mail Steam-ship Company, formed in 1847, is much the largest maritime undertaking yet organised, as distinctly American and under the flag of the United States, and their first steamer, the *California*, which left New York on the 6th of October, 1848, was the first to bear the American flag to the Pacific Ocean. To form a steam-ship establishment 4000 to 5000 or, as it was at that time, 13,000 miles from home, where the necessary supplies could only be obtained with the greatest difficulty in a country wholly new, was an undertaking of no ordinary hazard and difficulty. Nevertheless, there appeared to be ingredients for success sufficient to encourage the projectors to increase their fleet with extraordinary rapidity soon after they commenced operations; and there were at that period no steam-ships afloat finer than the *Panama*, *Oregon*, *Tennessee*, *Golden Gate*, and *Columbia*, which followed the *California* in rapid succession. Pacific Steamship Company started, 1847.

From a small beginning, the Pacific Company has now one of the best fleets belonging to the United States, though the difficulties in forming it were

probably far greater than in the case of any of the other American companies. Among these, may be mentioned the necessity of constructing large workshops and foundries for repairs, together with the creation at Bernicia of an establishment, where marine engines could be constructed; they had, also, to build their own dry dock, for that of the Government at Mare Island was not ready until 1854, the company's dock being for some years the only accommodation of this kind in the Pacific. The company had also to form establishments at Panama, San Francisco, and Astoria, with coal depôts, at a time when labour and materials were excessively high, and when the coal itself, whether brought from the Eastern States of the American continent or from England, was invariably, and necessarily, carried round Cape Horn, seldom or never costing less than from 20 to 30 dollars, and, in one instance, 50 dollars per ton.[1]

Cost of establishing it.

But, from first to last and amid all its difficulties, the Pacific Steam-ship Company has carried on these distant services with remarkable regularity. Even in the earlier portion of its career, the steamers performed the service between Panama and San Francisco, a distance of 3300 miles, at an average speed of 254 miles per day, touching at various ports on the way; the company has also by its semi-monthly line from San Francisco to Oregon materially assisted in populating that rich and beautiful agricultural district. Nevertheless, had it not been for the discovery of the gold fields of California, the undertaking must have been a great commercial failure;

Speed of its vessels.

Difficulties to encounter.

[1] Coals are now worked from mines on the coast, and, from this and other causes, the price of coals on the Pacific coast has been materially reduced."

indeed, even within the last few years, its history has been one of disaster, while its management has been characterized by a succession of mistakes each one graver than the last. Its most formidable rival is now the Central Pacific Railroad Company with other allied lines, which carry off a large portion of the more valuable goods previously conveyed in steamers, viâ Panama, between the northern and eastern states and California.

Number of its steamers.

The Pacific Steam-ship Company is, however, still by far the greatest of the American maritime undertakings, having at present in commission thirty-three very fine steamers of an aggregate capacity of 74,000 tons of cargo, exclusive of the large space assigned to passengers. It has thirty-five chief agencies on the Atlantic and Pacific coasts of the United States and in the West Indies, Mexico, Central and South America, Canada, England, China, and Japan. There are altogether fifty ports where its steamers call, three of which are on the Atlantic and forty-seven on the Pacific: these figures may in some measure afford my readers an idea of the extent of its commercial operations.

Services performed.

The steamers engaged on the China line leave San Francisco for Yokohama and Hong Kong every alternate Saturday, connecting at Yokohama with their branch steamers for Shanghae and at Hong Kong with the English and French steamers for Singapore and the principal ports in India, and, viâ the Suez Canal, with the Mediterranean and Atlantic ports of Europe. The New York and Panama line connects at Aspinwall with the Royal Mail Steam Packet Company to Southampton; with the West

India and Pacific Steam Packet Company to Liverpool; with the Hamburg-American Steam Packet Company to Hamburg, and with the Companie Générale Trans-Atlantique to France. At Panama, they connect with the Pacific Steam Navigation Company to all South American ports. The Mexican and Central American line leaves San Francisco every alternate Thursday for Panama, stopping at all Mexican and Central American ports. The New York and Panama line leaves New York every alternate Saturday and San Francisco every alternate Wednesday.

China and Japan line. The China and Japan line, which the company is now promoting with great vigour, was not started until the 1st of January, 1867, when the first of its fleet passed out of the "Golden Gate" of California bound across the Pacific to those ancient nations. The *Great Republic*, *China*, *Japan*, and *America*, all of them wooden vessels with paddle-wheels and "walking beam" engines, soon followed. These vessels, of somewhere about 4000 tons each, make the voyage from San Francisco to Yokohama in twenty-two days, thence to Hong-Kong in seven more, the whole distance occupying, with the stoppage at Yokohama, thirty days.

Until recently, the service was monthly each way, but the rapid increase of trade has now induced the company to despatch a steamer from each end, once a fortnight. Between Yokohama and Shanghae, this company runs, in connection with the large steamers, many smaller vessels which, passing through the inland seas of Japan and calling at Hiogo and Nagasaki, have secured a large share of the local traffic, at the same time feeding the trunk line, the vessels

of which have very extensive accommodation for the numerous Chinese passengers, between Hong-Kong and San Francisco. Though this company now finds a large and increasing amount of employment for its ships in goods, as well as passengers, consisting chiefly of wheat, flour, treasure, and general merchandise for China, and tea, sugar, cleaned rice, oil, and miscellaneous articles in return, it is largely subsidised by the American Government, which, as well as its subjects, shows considerable jealousy of the steamers of other countries competing for the same trade.

In 1874, two pioneer steamers of an English company attempted to compete with those of the Pacific Steam-ship Company, but the promoters appear to have been unable to obtain sufficient capital to enlarge their service and maintain the opposition, as they consented, after a few months' trial, to charter their vessels to the American company, which has also added to its fleet now engaged in this trade two new and large vessels, the *City of Pekin* and the *City of Canton*.[1]

As the Central Pacific Railroad was opened soon after the inauguration of the line of steamers to China,

[1] These "magnificent" vessels are each 5560 tons burden, and are 423 feet in length, 48 feet wide, and 38 feet deep. They are the largest steam-ships that have ever carried the American flag. It is confidently believed in America, that the running time from Hong Kong to San Francisco, viâ Yokohama, by these vessels will be reduced to within twenty days; and they are guaranteed by the builder, under a heavy penalty, to make fourteen and a half knots per hour. The *City of Pekin*, on her trial trip, made fifteen knots an hour, with fifty-three revolutions per minute and 57 lbs. of steam. This company has now in course of construction other three steamers similar in size; all are being built of *iron* at Chester, Pa., U.S. Each vessel will have capacity for 800 passengers, and 3000 measurement tons of freight.

passengers as well as a large proportion of the teas and other Chinese produce and merchandise are now transported by it, instead of being conveyed as hitherto from China, by way of the Cape of Good Hope, or across the Pacific Ocean to San Francisco, and thence, viâ Panama, to New York, Boston and other ports on the north-eastern seaboard.

"Law line" of steamers.

That San Francisco was, in the opinion of the Americans, destined to become a great central depôt of commerce, and ought, therefore, to be encouraged by every means in their power, may be inferred from the circumstance that, in 1847, when the Pacific Mail Steam-ship Company commenced operations, another company, known as the "Law Line," established by Messrs. Law, Roberts, and Company, of New York, received also a subsidy for carrying the United States' mails between New York, California, and Oregon monthly, although there was not then sufficient trade for even one monthly line of steamers.

South American Steam-ship Company.

Running in connection with the steamers from New York to Aspinwall, the Americans have another line, consisting of twelve very fine steamers ranging from 500 to 2000 tons each, plying between Panama, Valparaiso, and the intermediate ports, rivalling the vessels of the English Pacific Steam Navigation Company, and largely sharing in the commerce between San Francisco and the South American Republic, a trade destined to become one of vast magnitude and of great public importance. Nor do they seem disposed to limit their operations to the shores of the Pacific, for besides the great line now traversing that ocean to China and Japan, they evidently contemplate at no distant date to run lines of their own

steamers from San Francisco and Panama to our Australian Colonies. "One of the most pressing needs of the day," remarks a writer in the leading San Francisco journal of January 1875, "is for the establishment of a permanent steam communication with Australia, and it is a disgrace to the public spirit of our community that it has not been satisfactorily effected."

Mr. Randall's projected large American steamer.

Nor are the Americans inclined to rest satisfied with the present size of their steamers, but, with a prudence not displayed by the projectors of our *Great Eastern*, they have hitherto regulated their dimensions by the requirements of the trade in which they intended to employ them. When I visited Philadelphia, in the autumn of 1860, several merchants of that city brought under my notice the designs and model of a steam-ship they then contemplated building, and which, though not one-half the dimensions of our own vast *Leviathan*, was double the size of any other vessel then afloat; they had, indeed, formed a company which they styled the Philadelphia and Crescent Steam Navigation Company, expressly for the purpose of constructing a line of such vessels to trade with Great Britain. The plans of this ship are now before me.

Into the estimates of profit and loss I need not enter, as their accuracy, or otherwise, has not been tested, but the plans of the projector, Mr. Randall, were considered of sufficient importance to justify the State legislature in granting to the company an Act of Incorporation. This vessel was to be 500 feet long, with a beam of 58 feet moulded, and to measure about 8000 tons. She was to have

Details of proposed ship.

"ample accommodation for 3000 passengers and 3000 tons of cargo," and to be "a regular 20-mile ship." She was to "have ample fuel room, sufficient to run 8000 miles without stopping for coal," and to have a "main saloon of 350 feet of uninterrupted length," and "175 family state rooms, with double beds in each of extra size, and a dining-room and drawing-room, each 150 feet long." For the comfort and convenience of excursionists, who, it was said, "will be induced, in consequence of the increased safety offered by these vessels to visit Europe in preference to Saratoga, Newport, Niagara, &c., there will be found on board a social hall, reading-rooms, and library 50 feet long, and a smoking-room 45 feet in extent, and numerous baths, comparing favourably with first-class hotels."

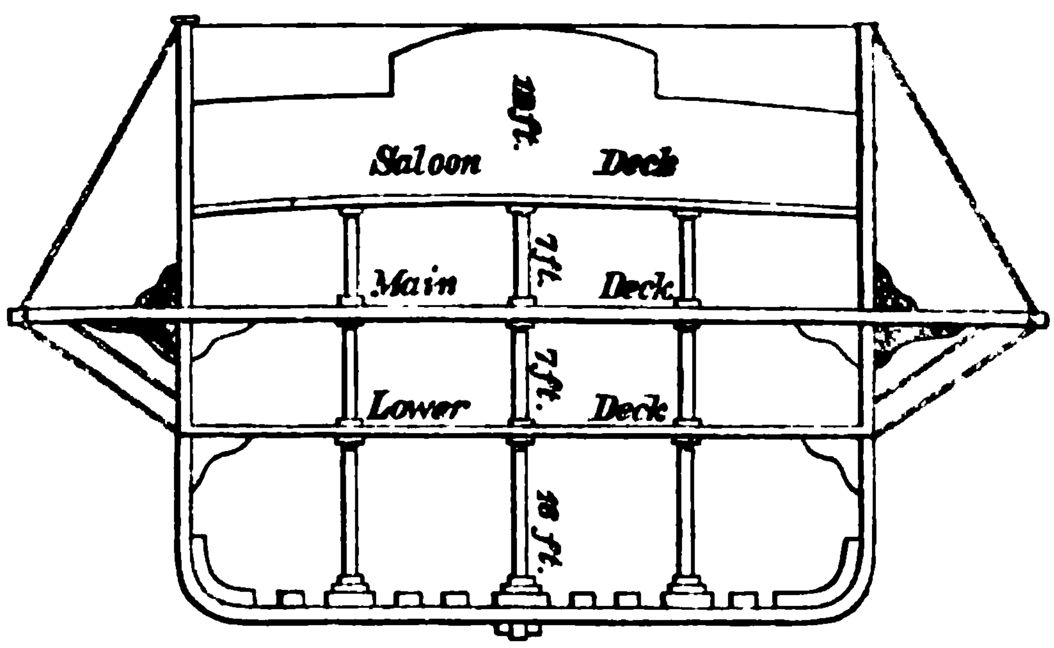
Two sets of paddle-wheels.

Her motive power was to consist of two sets of wheels, "constructed in such a manner and so placed as to obtain a vast increase of speed;" she was to be divided into seven water-tight compartments, and the engines were to be entirely distinct, 130 feet apart. She was to be constructed on the diagonal principle and trussed with bars of iron as shown in the following midship section. There was to be "a solid arch on each side of the ship, together with the

Principle of construction.

vertical arch and iron diagonal bracing, extending over the whole frame, affording a construction of strength and security never equalled."[1]

But her midship transverse section was the most striking feature of this great ship; it is in many respects novel, and so different from the midship section of any vessel constructed in other countries, that the following representation of it may prove interesting and instructive.



The proposed arrangements present an amount

[1] The advantages of this system of trussing are described by a practical authority, as follows: "Running fore and aft, and constituting the frame of the sides of the ship, are two arched trusses of wood and iron, of the most ingenious construction. The vertical depth, from the crown of the truss down to the level of the keel, is about 53 feet. In the truss is also interwoven a counter arch, the trusses, therefore, not only prevent the sinking of the two extremities and rising of the middle, but they likewise prevent any rising of the extremities, and sinking of the middle of the ship, and thus effectually prevent any tendency to bend or break in the direction up or down in a fore and aft vertical plane; and, by a most perfect system of lateral trussing interwoven with the tiers of beams, she is prevented from bending or breaking in the direction of a horizontal plane, running fore and aft through the ship. Where strain by tension or pulling is exerted, wrought iron is to be used, and where thrusts or compression is exerted, wood is used, and where both compression and extension are felt, wood and iron together are used."—Address by Captain T. J. Cram, delivered at the Board of Trade Room, Philadelphia, July 11th, 1860.

of accommodation for passengers greatly superior to any obtainable in vessels of similar size constructed on the principles generally followed by the shipbuilders of Great Britain. The almost dead flat floor, adopted with the American idea of, as far as practicable, skimming over the surface of the water, rather than forcing a passage through it, is at variance with the form hitherto considered by us most desirable where great speed is required. But we are daily expanding the breadth of the round and rising floors of our ships, and approaching the American form, and, so long as there is sufficient depth to secure stability,[1] some persons consider that vessels with flat floors and fine ends are the best models for speed as well as for capacity.

Advantages to be derived from vessels thus built.

Although the ocean-going steamers of Great Britain, as in the case of the great competition between the steamers of the Collins and Cunard lines, to which reference will presently be made, have, hitherto, in a commercial point of view, surpassed those of the United States, it is much to be regretted that Mr. Randall's ship was never built. As she was the nearest approach in size to the *Great Eastern* of any vessel hitherto contemplated, her trial would have

[1] So far as regards the stability of the proposed vessel, Captain Cram, who was a member of the United States' Corps of Topographical Engineers, remarks, in the lecture on her, delivered in 1860 at Philadelphia, as follows: "She is to be a four-storey ship. Commencing at the bottom and going upwards we have the first storey, a hold, 16 feet high in the clear, with ample room for the machinery, boilers, and coals, and for a large quantity of freight besides. All this great weight of engines, boilers, coals, and dead weight freight, which is to be stowed in the very bottom of the ship, will act as ballast placed in the right position to insure stability and to relieve the ship from that dangerous topheaviness usually observed in many sea-going steamers."

been interesting, especially as it was thought that her form and mode of construction presented greater elements of success as regards speed and capacity in proportion to her register tonnage; and, if we apply the formula for determining the strength of a truss, we shall find that, in proportion to the weight of materials used, with the system of bracing proposed, she would have more effectually resisted the twisting or writhing so fatal to long and heavily-laden ships when they encounter the violently agitated cross seas of the Atlantic Ocean.

Mr. Randall's experience of steamers employed on the Lakes and Pacific.

Such were the views of Mr. Randall, and, when it is considered that he was no mere theorist, but a man of large practical experience in such matters, there were even greater reasons to anticipate valuable results from the experiment. For twenty-two years before he propounded his scheme to the merchants of Philadelphia, Mr. Randall had been employed in building, fitting, and navigating steam-ships on the American lakes and on the Atlantic and Pacific Oceans:[1] and

[1] In 1833, Mr. Randall designed and built the *Wisconsin*, 218 feet in length and 38 feet in width, at Detroit, Michigan, and ran her successfully, under his own command, through three of the lakes between Buffalo and Chicago, carrying freight and passengers, in spite of strong head winds, on round trips of 2000 miles, averaging a speed quite as great as the *maximum* contemplated many years afterwards by the projectors of the *Great Eastern*. In 1845 he designed and navigated in the same trade the *Empire* of 251 feet in length, with a beam of 38 feet, at an average speed of 16 statute miles per hour. Soon afterwards the *City of Buffalo* and the *Western Metropolis*, constructed according to his design, were sent afloat. They were sister ships, each 340 feet in length with a beam of 42 feet, and far in advance of any ship England had then afloat, while their draught of water, when laden, was only 9½ feet. By a report which appeared in the *Cleveland Herald* (U.S.) [and there is no reason to doubt its accuracy], the trip between Buffalo and Cleveland was made at an *average* speed of 21 miles an hour by the *Metropolis*, while the *City of Buffalo* made a similar

the only difference between these ships and the one he projected for the European trade consisted in the increased size, and in the application of two distinct sets of paddle-wheels instead of one.

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voyage, averaging still greater speed in the ordinary course of trade. Nor were Mr. Randall's practical experiments in vessels of similar model and design confined to the lakes, for he commanded the *Yankee Blade*, a vessel of still larger dimensions, with a draft of 11 feet of water, on her voyage from New York to California round Cape Horn, encountering, successfully, a gale in which many vessels foundered; afterwards, he continued to ply with her for some years on the station between San Francisco and Panama.

CHAPTER IV.

Struggle between Great Britain and United States for the Atlantic carrying trade—English shipowners cleave to Protection—"Baltimore clippers" and "American liners"—The *Savannah*, the first American Atlantic steamer, 1819—The *Curaçoa*, 1829—The *Royal William*, 1833, from Quebec—The *Sirius* and *Great Western*, 1838—Successful voyages of these vessels—Details of *Great Western*—The *Royal William*, second of that name, the first steam-ship from Liverpool, 1838, followed by the *Liverpool*—Origin of the Cunard Company—Contract for conveyance of mails—Conditions—Names and particulars of the first steamers in this service—The *Britannia*—Comparative results of different vessels—Building (1839) and loss (1841) of the *President*—Building of the *Great Britain* in 1843—Advantages of iron ships—American auxiliary screw steamer *Massachusetts*, 1845—American line of steamers to Europe, 1847—First ocean race won by the English—Not satisfied with Cunard line, the Americans determine to start one of their own—Reasons for so doing—American shipowners complain justly of the "Protective" policy of their own Government—Nevertheless adopted—Collins line established—Original terms of subsidy—Dimensions of their steamers—Mr. Faron's visit to England—Details of the build of these vessels—Engines—Frame sustaining engines and dead weight—Cost of steamers greatly increased by demand for increased speed—Further details of competing lines—Speed obtained and cost—Great competition, 1850–1852—Results of it.

Struggle between England and the United States for the Atlantic carrying trade.

HAVING furnished a general outline of the rise and progress of propulsion by steam on the rivers, coasts, and lakes of the United States of America, and traced its advance in Great Britain to the period when the superiority of the screw over the paddle-wheel, and of iron over wood, had come to be generally

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acknowledged, I shall now ask my readers to accompany me while I endeavour to describe the great contest between these two countries for the carrying trade of the Atlantic. It is a grand story to tell, one far more worthy of record than the wars for maritime supremacy between Rome and Carthage, or than, perhaps, some wars of more recent times which, without any apparently useful object, have stained land and sea with the blood alike of the victor and the vanquished, rendering desolate many a once happy home.

The war I have now to relate was a far nobler conflict, consisting as it did in the struggle between the genius, scientific skill, and industry of the people of two great nations, commenced, too, and, continued throughout without bloodshed and with a fair field, neither country having, in the direct trade, any special legislative advantages.

Though the Americans still retain the whole of their river, lake, and coasting trade, including even the distant voyage between New York and California, for the immediate benefit of their own shipping, the vessels of both nations conduct on equal terms the intercourse between the mother-countries, and have done so for more than half a century. But when, towards the close of the War of Independence, the struggle for supremacy commenced, the shipping of both England and America were, in all branches of their maritime commerce, under the leading-strings of their respective legislators. England would not then allow American vessels to trade with most of her vast possessions and, while thus nursing her shipowners, prevented the mass of her people from deriving the

advantages invariably flowing from a natural and wholesome competition. Nor did she, indeed, confer any real benefit on this favoured class: on the contrary, she taught them to lean on Protection, instead of depending on their own skill and industry. The consequences were apparent in even the earlier results of this struggle. Having ample fields for employment exclusively their own, English shipowners did not enter with their wonted energy, into the direct carrying trade between their own country and America, which was so rapidly developed after the Americans had become independent; they remained satisfied with those branches of commerce expressly secured to them by law, just as the boy too frequently does who, receiving a small patrimony by his parents, cares not to exert himself to increase it and, consequently, leaves others not so highly favoured, to surpass him in the race of competition for wealth and independence. Thus the shipowners of Great Britain did not care to continue their vessels in the trade with America in a competition, on equal terms, with those of that country, especially when they found they would have to produce a superior class of vessel and to use extra exertions, to make this trade pay as well as did their protected branches of oversea commerce without the additional trouble of "improvements." It was otherwise with the shipowners of the United States, for there was then no other branch of oversea trade where the laws of nations allowed them to compete on equal terms with foreign vessels.

English ship-owners cleave to Protection.

Although possessing the advantage of vast forests of timber for the construction of their ships, the

American shipbuilders were obliged to import their iron[1] from Great Britain, their hemp from Russia, and many other articles necessary for the equipment of their vessels from other and distant countries; they did not, therefore, especially as skilled labour was higher at home than in Europe, engage in the vigorous though peaceful struggle, I am about to describe, with any special advantages, but, being equal in energy and industry, they had the incalculable advantage of being obliged to depend on themselves. They, consequently, set to work to construct that description of merchant-vessel likely to yield the most remunerative returns, adopting the best mechanical contrivances within their reach, so as to reduce navigation to the smallest cost consistent with safety and efficiency; and the world soon saw the results of their labours in their celebrated "Baltimore clippers" and the still more celebrated "American liners," which for a considerable period

"Baltimore clippers," and "American liners."

[1] The Americans are now rapidly developing their large natural resources of iron. "The iron ores of the United States" (London *Times*, 28th of May, 1875), "are plentiful and various, though some kinds are wanting; thus the 'spathose' or spar-like iron ore, scarce even in Europe, is very rare; and the ironstone of the liassic and oolite seams, which furnishes about one-third of our British pig-iron, appears to be wholly absent. On the other hand, the specular iron ore, the brown and red hematites, the clay and blackband ironstones, are good and abundant; and some of the deposits of magnetic iron ore—as at Lake Champlain, and at Cornwall, in Pennsylvania—are very remarkable. At Cornwall the deposit consists of a solid hill of ore, measuring roughly 500 feet in diameter, rising from the ground level to a height of 350 feet, and proved by borings to a depth of 180 feet below ground level. The iron mine at Port Henry—at the south-west corner of Lake Champlain, in the State of New York—is worked in a huge prism of ore, about 200 feet square, and descending at an angle of 26 to 40 degrees, to an unknown depth, the superincumbent rock being supported by pillars of solid ore, 40 feet square at the base and about 20 feet at the top, with a height of considerably more than 100 feet."

almost monopolised the carrying trade between Great Britain and the States.

Yet, strange to say, though the superiority of the merchant-vessels of the United States soon became only too apparent, scarcely any improvements were adopted by Great Britain, or indeed, by any other nation, until wiser statesmen than had hitherto guided the councils of this country swept away the whole paraphernalia of her Navigation Laws, and left her shipowners to rely entirely on their own resources.

I have already shown that this superiority consisted mainly in the fact that American ships could sail faster and carry more cargo, in proportion to their registered tonnage, than those of their competitors; but their improvements did not rest here. In considering the current expenses of a merchantman, manual labour is one of the most important items, and, herein, our competitors, by means of improved blocks and various other mechanical appliances, so materially reduced the number of hands that twenty seamen in an American sailing-ship could do as much work, and probably with more ease to themselves, than thirty in a British vessel of similar size. With such ships we failed successfully to compete; and although we have since far surpassed them in ocean steam navigation, the Americans were the first to despatch a steamer, for trading purposes, across the Atlantic.

In 1791, when the steam-boat was in its infancy—indeed, when it was hardly known—Mr. Fitch[1] of Windsor, Connecticut, boldly predicted that sailing-vessels would soon be superseded in the carrying trade between Great Britain and America by

[1] *Ante*, p. 42.

steamers, though it was not till 1819, that the American steam-ship *Savannah*, of 300 tons, arrived at Liverpool from Savannah, Georgia, in thirty-one days, partly steaming and partly sailing;[1] but as her horse-power was too small, while she was otherwise unsuited for ocean navigation, she did not prove commercially remunerative. The questionable success of the *Savannah*, combined with the fact that about this time, and for some years afterwards, men of science[2]

The *Savannah*, the first American Atlantic steamer, 1819.

[1] "Encyclopædia Britannica" (eighth edition), vol. xx. p. 639, "Steam Navigation." The *Savannah* was full rigged as a sailing-vessel with auxiliary steam power, and her paddles were removable.

[2] Dr. Lardner, in his "Encyclopædia" and elsewhere, had more than once expressed the opinion that no steam-ship would ever be able to make so distant a voyage as that of crossing the Atlantic, without re-coaling. Having entered on details with regard to this important question in a lecture he delivered at Liverpool in December 1835, I consider it desirable to give the following extract from it, as reported in the *Liverpool Albion* of the 14th of that month, the matter being one of considerable historical interest:

"STEAM COMMUNICATION WITH AMERICA.—Dr Lardner then proceeded to observe that one of the grandest projects which had ever occupied the human mind was at present in the progress of actual accomplishment. He meant that of constructing a great highway for steam intercourse between New York and London. Part of the highway was in process of formation. It consisted of several stages—that of the rail-road from London to Birmingham; that from Birmingham to Liverpool, and the steam intercourse with Dublin; but there was another stage—that from Dublin to Valentia—which had as yet hardly been thought of. Ireland was a country which, with all her political disadvantages, was blest by nature with a vast number of physical advantages, and among the rest he might reckon a vast number of excellent harbours. No country in the world could boast of so many fine and spacious ports, bays, and roadsteads. She had many harbours on her west coast, which would serve admirably as stations for steam conveyance across the Atlantic; but Valentia had been selected as the extreme westerly point suitable for that purpose. It was a fine anchoring ground by an island of that name on the coast of Munster. The distance from Dublin to this point was under 200 miles, which might be traversed in about eight hours. The nearest point of the Continent of North America to this point of Ireland was St. John's in Newfoundland. The distance between the two was about 1900 miles, thence

were demonstrating, at least to their own satisfaction, that the navigation of the Atlantic by steam power

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to Halifax in Nova Scotia there would be another run of 550 miles, and from that to New York would not exceed the admissible range; but touching at Halifax would be desirable for the sake of passengers. The only difficulty would be as to the run from Valentia to St. John's; and the voyage from Dublin to Bordeaux and back, a distance of between 1600 and 1700 miles, with the same stock of coals, came very near this distance. It must be observed that westerly winds blew almost all the year round across the Atlantic. They were produced by the trade winds being the compensating cause that restored the balance which these served to destroy, according to that beautiful principle in nature which always provides a remedy for any derangement in the deranging cause itself. As a last resource, however, should the distance between Valentia and St. John's prove too great, they might make the Azores a stage between, so that there remained no doubt of the practicability of establishing a steam intercourse with the United States. *As to the project, however, which was announced in the newspapers of making the voyage directly from New York to Liverpool, it was, he had no hesitation in saying, perfectly chimerical, and they might as well talk of making a voyage from New York or Liverpool to the moon.* The vessels which would ultimately be found the best adapted for the voyage between this country and the United States would be those of 800 tons, which would carry machines of 200 horse-power, and would be able to stow 400 tons of coal. To supply a 10 horse-power, daily required an expenditure of a ton of coals, and, consequently, 200 horse-power would require 20 tons of coal daily; but if the vessel carried 400 tons of coal only, it would not be practicable to undertake a voyage which would require the whole of that quantity. They must make an allowance of 100 tons for contingencies. Thus, in reckoning the average length of the voyage which might be undertaken by such a vessel, we might safely calculate upon 300 tons of coal, which would be sufficient for fifteen days, and it might fairly be concluded that any project which calculated upon making longer voyages than fifteen days without taking in a fresh supply of coals, in the present state of the steamboat, must be considered chimerical. Now, the average rate of speed of the Mediterranean packets was 170 miles per day, and the utmost limit of a steam voyage might be taken at 2550 miles; but even that could not be reckoned upon."

It is, however, fair to the scientific memory of Dr. Lardner to state that, in the eighth and last edition of his "Steam-engine, Railways," &c., 1851, pp. 294-309, he declares that he never stated that a "steam voyage across the Atlantic was *a physical impossibility*:" the more so, that he was of course well aware of the previous voyages of the *Savannah*

alone, was the dream of a visionary, prevented, for ten years, the renewal of this bold experiment, the American sailing-vessels continuing to retain the bulk of this carrying trade.

The *Curaçoa*, 1829; the *Royal William*, 1833, from Quebec.

The next step in Transatlantic steam navigation was the dispatch, in 1829, of an English-built vessel, the *Curaçoa*, of 350 tons and 100 horse-power, which made several successful voyages between Holland and the Dutch West Indies. On the 18th of August 1833, a steam-ship named the *Royal William*[1] sailed from Quebec and arrived at Gravesend on the 11th of September, having been detained three days at Nova Scotia on her way to England. But it was not until 1838 that the practicability of profitably employing vessels propelled by steam on an Atlantic voyage was fully tested. In that year, an advertisement appeared announcing that the "steam-ship *Sirius*, Lieutenant Roberts, R.N., Commander, would leave London for New York on Wednesday, the 28th of March, calling at Cork Harbour, and would start from thence on the 2nd of April, returning from New York on the 1st of May." Thus a company of merchants was found sanguine enough to

and *Curaçoa*; what he did say (especially at the meeting of the British Association at *Bristol in* 1836) was "that the long sea voyages which were contemplated could not be maintained with that regularity and certainty which are indispensable to commercial success by *any revenue which could be expected from traffic alone*, and *that, without a governmen subsidy of a considerable amount*, such lines of steamers, although they might be started, could not be permanently maintained."

[1] The *Royal William* was between 400 and 500 tons, built at Three Rivers, Canada, and her engines, constructed in England, were fitted into her at St. Mary's Foundry, Montreal. She only made this one Atlantic passage and was subsequently sold to the Portuguese Government.

test the practicability of regular steam navigation with the United States, by advertising, not merely the days of sailing from England, but, also, those of arrival and departure from America. Circumstances, however, delayed the departure of the *Sirius* until the morning of the 4th of April, when she started, at ten o'clock, with ninety-four passengers. Although not built for Transatlantic navigation, having been previously employed by the St. George Steam Navigation Company in their trade between London and Cork, the *Sirius* was much superior in size to either of the three vessels which had previously made the voyage, being about 700 tons register with engines of 320 horse-power, constructed by Thomas Wingate, of Glasgow.[1]

The *Sirius* and *Great Western*, 1838.

[1] It is only due to the memory of the late Mr. MacGregor Laird, who, with his brother, the late Mr. John Laird, M.P. for Birkenhead, did so much to encourage Ocean steam navigation in its infancy, to state that the *Sirius* was placed on the Transatlantic service on his recommendation, and that, so early as 1836, he was chiefly instrumental in founding the British and American Steam Navigation Company which chartered this vessel from the St. George Company. See letter from Mr. A. Hamilton of St. Helen's Place, London, "the friend and executor of the late Mr. MacGregor Laird," which appeared in the *Shipping and Mercantile Gazette* of the 15th May, 1873: in this paper, also, appears a copy of a letter which Mr. Laird, under the signature of "Chimera," addressed to the *Liverpool Albion* on the 28th December, 1835, in reply to Dr. Lardner's fallacious prognostications that a steam voyage across the Atlantic was "perfectly chimerical," from which I take the following extract:

"By what process of reasoning Dr. Lardner has fixed the ultimate size of steam-vessels for the Atlantic at 800 tons and 200 horse-power does not appear, which is the more to be regretted, as it must be a peculiar one, from the size of the vessels very little exceeding that of several in the coasting trade, and the power being much less; but I am not bound to take this for granted, particularly as all my experience has proved that we as yet have never had to complain of the size of the vessel if the power has been proportionately increased; on the contrary, the Dublin boats have crept up from 250 to 500 and 600, and the Clyde from 200 to 400 tons, and other lines in the

But the *Sirius* was soon surpassed by the *Great Western*, which three days afterwards (the 7th of April, 1838) followed her with goods and passengers for New York. As the *Great Western*, the marvel

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same proportion. In reasoning, therefore, upon a line of steam communication between Great Britain and New York, I must reason from analogy, and fortunately Dr. Lardner gives me the data. The *Leeds*, it appears, makes the voyage to and from Bordeaux, a distance of 1600 miles, with one supply of coals. The *Leeds* is, I believe, 420 tons and 140 horse-power, and her displacement between her light and load marks will be about 80 tons to one foot, or perhaps only 70. Now, the distance from Liverpool or Portsmouth to New York is 3000 nautical miles or 3500 statute miles, a little less to Liverpool. Suppose the *Leeds* be trebled in capacity, so that her displacement should exceed 200 tons per foot draught, it is not necessary to treble her power, as double power propels more than double bulk: but allow her 300 horse-power, her light draught of water would be about 11 feet with her machinery on board, and with 800 tons of dead weight on board, about 15. I take the consumption of coals at 30 tons per day, and a mean speed of 10 miles per hour, and at an expenditure of 525 tons of common coal, or 420 of Langennich, I land my passengers in New York, Portsmouth, or Liverpool in something less than fifteen days. I have not allowed anything in this calculation for the saving of fuel that would accrue in these large engines by working them expansively, but have taken the consumption at 9½ lbs. per horse per hour, and with common coal I would have a surplus of 275 tons dead weight for passengers and goods. One objection will, I am aware, be made, viz., that my average speed is too great, and if I admitted that the *beau idéal* of a steam-vessel was embodied in one of His Majesty's Mediterranean steam-packets the objection would be fatal; but what is the fact? (no less wonderful than true), the average speed of private vessels far exceeds them; and, to prove that the average speed of 10 miles per hour is not 'chimerical,' I may state that the average speed of the *Dundee* and *Perth*, in all weathers, winter and summer, fair or foul, exceeds 11 miles per hour; that the average speed of the *Monarch* is 10½ miles per hour; and that the *Medea* steam-frigate averaged more than 10 miles per hour on her voyage to Malta. Now, I am of opinion that the *Dundee*, *Perth*, *Monarch*, and *Medea* are to be, and will be, beat, but not by vessels of 800 tons and 200 horse-power. I hope, Mr. Editor, I have proved that it is easier to go from Portsmouth or Liverpool to New York than to the moon; that it is more convenient to go direct than through the first 'gem of the sea;' and the last, though not the least consideration, that if we wish to go at all by steam, we had better not wait for the Valentia Railway."

of the period, was the first steam-ship specially constructed for the now vast trade between Great Britain and the United States, it may interest my readers to know that she was built of wood by Mr. Patterson, of Bristol, according to his own design, and that her dimensions were 212 feet in length between the perpendiculars, 35 feet 4 inches breadth of beam, and 23 feet 2 inches depth of hold; registering 1340 tons, builders' measurement.[1] Her engines

[1] Builders' measurement, or O.M., is the measurement of a vessel according to the old law of 1773 (13 George III., Chap. LXXIV.) which prescribed as follows: "The length shall be taken on a straight line along the rabbet of the keel of the ship, from the back of the main stern-post to a perpendicular line from the fore part of the main-stem under the bowsprit, from which substracting three-fifths of the breadth, the remainder shall be esteemed the just length of the keel to find the tonnage; and the breadth shall be taken from the outside of the outside plank in the broadest place in the ship, be it either above or below the main wales, exclusive of all manner of doubling planks that may be wrought on the sides of the ship; then multiplying the *length* of the keel by the *breadth* so taken, and the product by *half the breadth* and dividing the whole by ninety-four, the quotient shall be deemed the true contents of the tonnage."

Though another Act was passed in 1834 (Act 5th & 6th William IV. Chap. LVI.) which was again amended by the 6th & 7th Victoria, Chap. LXXXIV., and consolidated by 8th & 9th Victoria, Chap. LXXXIX., known as the "new measurement, or N.M." the old law remained in use with all shipbuilders in their contracts until 1854, when the law (proposed and carried out by Moorsom) now in force, was passed. By this law, the internal cubic contents of a ship are ascertained, and the register tonnage (on which all fiscal dues are levied) ascertained by certain calculations which produce as nearly as possible the same results in the old measurement of all ships built since 1854 (see *ante*, vol. iii. note, p. 310), and thus the necessity is avoided of altering the rates charged upon shipping, for light, dock and other dues; under the present law, which is generally approved, an allowance is made for the space occupied by the engines in steam-vessels, so that the register tonnage on which all dues are levied is the gross admeasurement, less the space occupied by the propelling power. The mode of arriving at this, adopted by different nations, has of late been a question of much discussion with reference to the dues charged on vessels passing through the Suez Canal.

(on the side lever principle) were 440 horse-power, constructed by Messrs. Maudslay, Sons, and Field, of London, having cylinders 73½ inches in diameter and 7 feet stroke, making twelve to fifteen revolutions per minute.[1] She was commanded by Captain Hosken.

In the interval between the sailing of the *Sirius* and the *Great Western* and their arrival at New York, much doubt prevailed as to the probability of their accomplishing the voyage in safety, and this uncertainty was increased by the arrival at ports in Great Britain, of vessels from America, without having encountered either of them; it was forgotten for the moment, that, in the immensity of the ocean, vessels may easily miss each other although traversing the same zones. They were however at length spoken with by the *Westminster*, an American sailing packet, the *Sirius* on the 21st April, within six hours' sail of her destination, and the *Great Western* on the 22nd. The former reached New York on that day after a passage of seventeen days; the latter completed the passage in two days' less time, having arrived (without any accident in either case), on the 23rd of that month.

[1] The "Principle of Construction" of this vessel is clearly stated in the following note given in Mr. Brunel's life at p. 234: "To enable the ship to resist the action of the heavy Atlantic waves, especial pains were taken to give her great longitudinal strength. The ribs were of oak, of scantling equal to that of line-of-battle ships. They were placed close together and caulked within and without before the planking was put on. They were dowelled and bolted in pairs; and there were also four rows of 1½ inch iron bolts, 24 feet long, and scarfing about 4 feet, which ran longitudinally through the whole length of the bottom frames of the ship. She was closely trussed with iron and wooden diagonals and shelf-pieces which, with the whole of her upper works, were fastened with bolts and nuts to a much greater extent than had hitherto been the practice."

The safe arrival of these ships at New York was hailed with immense acclamation, thousands of persons having gathered early in the morning to bid them welcome, and, as this, too, is a matter of historical interest, I shall trouble my readers with the substance of the accounts of their arrival as they appeared, at the time, in the public journals.[1]

Successful voyages of these vessels.

The *Sirius* sailed on her homeward voyage on the afternoon of the 1st of May, her advertised time, and the *Great Western* on the 7th of that month. The former reached England on the 18th of May, the latter on the 22nd, being respectively, sixteen and fourteen days on the passage. The whole distance run from Bristol to New York, by the *Great Western*, was 3125 knots,[2] her average speed being 208 miles each day, or 8·2 per hour, consuming 655 tons of coal. Her return passage was accomplished

Details of the *Great Western*.

[1] "ARRIVAL OF THE 'GREAT WESTERN' AND 'SIRIUS' STEAMERS AT NEW YORK.—At three o'clock P.M., on Sunday, the 22nd of April, the *Sirius* first descried the land, and, early on Monday morning, the 23rd, anchored in the North River immediately off the battery. The moment the intelligence was made known, hundreds and thousands rushed early in the morning to the battery. Nothing could exceed the excitement. The river was covered during the whole day with row-boats, skiffs, and yawls, carrying the wondering people out to get a close view of this extraordinary vessel. While people were yet wondering how the *Sirius* so successfully made out to cross the rude Atlantic, it was announced about eleven A.M. on Monday, from the telegraph, that a huge steamship was in the offing. 'The *Great Western*!—the *Great Western*!' was on everybody's tongue. About two o'clock P.M. the first curl of her ascending smoke fell on the eyes of the thousands of anxious spectators. A shout of enthusiasm rose on the air. . . . . During the first part of the passage of the *Sirius* she made slow progress, her speed varying from 4 knots 4 fathoms per hour to 7; the latter portion was at the rate of 8 to 11 knots. Thus the grand experiment has been fairly and fully tested, and has been completely successful. The only question now in the case is that of expense. Can steam-packets be made to pay?"

[2] Sixty knots are equal to sixty-nine geographical or statute miles.

at an average of 213 knots each day, or close upon 9 knots an hour, with a consumption of 392 tons of coal (the difference of consumption arising no doubt in a great measure from the prevalence on her homeward passage of westerly winds); her average daily consumption on this occasion varied from 27 tons, with expansive gear in action, to 32 tons without it.[1]

As the *Sirius* was not intended for the American trade she made only the one voyage across the Atlantic and, on her return to Liverpool, was dispatched to London to open up steam communication between that city and St. Petersburg, where she was for some years successfully employed.

Royal William, the second of that name, the first steamship from Liverpool, 1838.

But another steam-vessel was soon engaged to take the place of the *Sirius*. On the 6th of July, 1838, a paragraph in the public journals[2] announced

[1] The *Great Western* ran regularly between Bristol and New York till the end of 1846. In 1847 she was sold to the West India Royal Mail Steam Packet Company, and was long one of their best vessels. In 1857 she was broken up at Vauxhall, being no longer able to compete profitably with the new class of steamers which, by that time, had been placed on the different Transatlantic lines.

[2] "DEPARTURE OF THE FIRST STEAM-SHIP FROM LIVERPOOL TO NEW YORK.—On Thursday evening the *Royal William*, the property of the City of Dublin Steam Packet Company, set sail on her first voyage for New York. The *Royal William* was announced to sail for New York at half-past six o'clock. At that time Prince's Pier was lined towards the river with a dense crowd from top to bottom, and the rigging of the shipping in the Prince's Dock was densely manned with sailors. Every conceivable standing place on George's Pier was crowded to excess. The deck of the vessel was crowded with passengers and their friends, and those whom curiosity had taken there. Exactly at half-past six o'clock the anchor was weighed, and, immediately, as the noble vessel began to move she was greeted with the enthusiastic cheering of thousands of spectators, which were responded to by those on board, whilst from Woodside, Birkenhead, Rock Ferry, the Pier, and the steamboats in the river on all sides, scores of cannon thundered forth the rejoicings of their possessors . . . . . . She is built by Messrs. Wilson and her engines are from the manufactory of Messrs.

the interesting fact that the enterprising merchants of Liverpool, who now hold the great bulk of the Anglo-American trade in their hands, had dispatched their first steam-ship, the *Royal William*, though the second of that name, to New York.[1]

Although the practicability of steam navigation across the troubled waters of the Atlantic had now been triumphantly established, other steam-ships having followed the *Royal William* in rapid succession, many years elapsed before the magnificent sailing-vessels which American energy and skill had created, were driven from the trade.

In October 1838, Sir John Tobin, a well-known merchant of Liverpool, seeing the importance of the intercourse now rapidly increasing between the old and new worlds, dispatched on his own account, a steamer to New York. She was built at Liverpool, after which place she was named, and made the

followed by the *Liverpool*.

Fawcett and Preston. The vessel is 817 tons burthen, and her engines are 276 horse-power, and work expansively at a 5 feet 6 inch stroke. The consumption of coal is 14 cwt. 2 lbs. per hour. She has furnaces which completely ignite the smoke, and are a saving of 33 per cent. in the consumption. The smoke from the chimney top is scarcely perceptible. She has fuel on board for 4500 miles; almost sufficient to take her out and bring her back again. Her length is 175 feet; breadth of beam 27 feet; and depth of hold 17 feet 6 inches. She is also fitted with four water-tight wrought-iron bulk-heads for safety from foundering and fire. She is fitted up with floats, which neutralize the vibration. Her paddle-wheels are 24 feet in diameter, and, owing to the great depth of the vessel in the water from the large quantity of coal on board, the paddles are 6 feet in the water. In smooth water the vessel sails 11½ knots an hour. Her cabins, which are exceedingly neatly fitted up, contain accommodation for eighty passengers. There are two principal cabins and several private cabins. Thirty-two passengers went out in her."

[1] The *Royal William* made her first passage from Liverpool to New York in nineteen days and the passage home in fourteen and a half days.

passage outwards in sixteen and a half days. It was now clearly shown that the service could be performed, not merely with profit to those who engaged in it, but with a regularity and speed which the finest description of sailing-vessels could not be expected to accomplish. If any doubts still existed on these important points the second voyage of the *Great Western* set them at rest, she having on this occasion accomplished the outward passage in fourteen days sixteen hours, and the homeward passage in twelve days fourteen hours, bringing with her the advices of the fastest American sailing-ships which had sailed from New York long before her; and thus proving the necessity of having the mails in future conveyed by steamers.

But this idea so far from being new was coexistent with the introduction of steam itself for the purposes of navigation; nor indeed was it the idea of any one person interested in the trade between Great Britain and the United States of America, though one man set himself more zealously to carry it into practical and continuous operation than any one else.

Origin of the Cunard Company, 1838.

So far back as 1830, Mr. Samuel Cunard of Halifax, N.S., contemplated the establishment of a mail service between the two continents, his original plan, which he followed up, being to run steamers from Liverpool to Halifax (that harbour presenting unusual facilities for the reception of steam-vessels) and thence to Boston in the United States.

About that time the Government of Bombay which had just launched the *Hugh Lindsay*, and the East India Company were considering the introduction of larger steam-vessels for their naval service, and, as

Mr. Cunard was personally known to Mr. Melvill, then secretary to that Company, he placed himself in communication with that gentleman, making known to him his views, and requesting to be favoured with an introduction to any shipbuilder in this country or other persons likely to join him in carrying out his project. Mr. Melvill furnished him with a letter to Mr. Robert Napier, the well-known engineer and shipbuilder of Glasgow, and through him Mr. Cunard was led to discuss this important undertaking with Mr. George Burns of that city, and his friend and correspondent Mr. David MacIver of Liverpool.[1] Both those gentlemen

[1] Mr George Burns, whose family had for many years held a highly respectable position in the city of Glasgow (his father having been for the very long period of seventy-two years the minister of the Barony parish of that city), entered into partnership with his elder brother, James, in 1818, and in that year founded the great business firm still carried on in Glasgow. In 1824 they became owners, along with the late Hugh Matthie of Liverpool, of six sailing-vessels trading between that port and Glasgow, and in the same year they engaged in steam navigation between Glasgow and Belfast. They next substituted steam for sailing-vessels in the Glasgow and Liverpool trade and, in 1830, amalgamated this business with that of the Messrs MacIver of Liverpool, with whom they afterwards made arrangements to establish the line of steamers with the United States of America from Liverpool, suggested by Mr. Cunard. The business thus created was, in its various branches, carried on by Messrs. G. and J. Burns in Glasgow, by Messrs. D. and C. MacIver in Liverpool, and by Messrs. S. Cunard and Co., in Halifax, N.S., under the superintendence of Mr. Cunard at Boston, and, subsequently, when New York was embraced in the line, under the management of his son Mr., afterwards Sir Edward, Cunard, Bart. Mr. David MacIver died a few years after the formation of the Cunard line. Mr., afterwards Sir Samuel, Cunard, Bart., and his son, Sir Edward, who died more recently, have been succeeded by Mr. William Cunard, now managing the affairs of the company in London and Mr. George Burns, alone, survives of the Glasgow firm, the business of which is now carried on by his two sons, Mr. John Burns (whose abilities and philanthropy are alike conspicuous), and his brother, Mr. James Cleland Burns, and that in Liverpool by Mr. Charles MacIver (a gentleman of remarkable energy and ability) and his sons.

entertained with favour the proposals of Mr. Cunard, and, subsequently, agreed to co-operate with him in finding the requisite capital and ships, should he be enabled to secure the contract for the conveyance of the Transatlantic mails.

Contract for the convey-ance of the mails.

The regularity of the passages of the *Great Western* satisfied the British Government as to the superiority of steam over sailing-packets, and, in October 1838, the Admiralty issued advertisements for tenders for the conveyance of the North American mails by steamers. Much to the annoyance of the *Great Western* Company, who did not contemplate any serious opposition to their offer, the tender from Mr. Cunard, as the lowest and, in many other respects the most favourable in its conditions for the public, was accepted, the contract being entered into in the name of Samuel Cunard, George Burns, and David MacIver; and from this sprung the vast private maritime undertaking now popularly known as the Cunard Company.

Con-ditions.

The original conditions of the contract were that, for the sum of 55,000*l.* per annum, Messrs. Cunard, Burns, and MacIver should supply three suitable steam-ships and perform two voyages a month from Liverpool to the United States, leaving England at certain periods; but, afterwards, it was thought desirable to have fixed days in America as well as in England for departure By a subsequent arrangement, four boats were required by the Admiralty to be provided by Mr. Cunard instead of three, subject to certain other conditions for which the subsidy was increased to somewhere about 81,000*l.*[1] per annum.

[1] Mr. Cunard in his evidence before the Select Committee "On

For the performance of this contract Mr. Cunard and his co-partners placed on the line four steamships[1] in every way adapted for the service so far as the knowledge of the period extended, and from the commencement of the company until the present day the Cunard Company have without exception supplied vessels greatly exceeding the stipulated power required by their postal contracts. The whole of the first four vessels were constructed of wood on the Clyde by its leading shipbuilders, and the engines were supplied by Mr. Robert Napier, long celebrated in his profession. They were nearly alike in size and power, and, that my readers may compare them with the steam-vessels of to-day a drawing of the *Britannia* (which commenced the service by sailing from Liverpool on 4th July, 1840) is furnished (page 182);

Names and particulars of first steamers in this mail service.

The *Britannia*.

Halifax and Boston Mails" (Parl. Paper, 1846, No. 563), stated that 3,295*l.* per voyage was paid for the service. And, in 1874, Mr. John Burns, in his examination before the Royal Commission "On Unseaworthy Ships," said, in reply to question 16,982: "The original contract of the Cunard Company which was made by my late partner, Sir Samuel Cunard, was made with the Admiralty, and under the Admiralty all the ships were inspected by Admiralty officers, and there were certain restrictions in the contract as to allowing them to be used in time of war. These ships were all wooden ships and they had to carry naval officers on board, and to do other things which caused a good deal of trouble and expense to us. In the last contract which we negotiated we said that we would take less money, if certain of these restrictions were taken away from us. Therefore, we are now under a contract of 70,000*l.* a year, and carry no naval officers on board."

[1] Name.	Length between Perpendiculars.	Extreme Breadth.	Depth of Hold.	Nominal Horse-Power.	Burden in Tons.
	Feet.	Ft. In.	Ft. In.		
Britannia . . .	207	34 4	22 6	423	1,156
Acadia	206	34 6	22 6	425	1,136
Caledonia . . .	206	34 6	22 6	425	1,139
Columbia . . .	207	34 2	22 4	425	1,138

THE "BRITANNIA."

the particulars of her construction, in all essential details, are likewise herewith supplied.[1]

These vessels commenced the mail service in 1840 between Liverpool, Halifax, and Boston, performing it with great regularity out and home at an average speed of about 8½ knots an hour, and giving complete satisfaction to the public on both sides of the Atlantic; indeed, when the *Britannia*, on her first voyage, was frozen up in the harbour of Boston, the

[1] Built on the Clyde by Mr. R. Duncan, in 1840. Left Liverpool on her first voyage, July 4th, 1840.

Material of vessel	Wood
Length, keel and forerake	207 feet
Breadth of beam	34 feet 4 inches
Breadth over paddle boxes	54 „ 8 „
Depth of hold	22 „ 6 „
Depth over planking	24 „ 8 „
Tonnage, builders' measurement	1,156 $\frac{46}{94}$
„ new „	1,155 $\frac{13}{100}$
„ of engine-room	535 $\frac{70}{100}$
„ register	619 $\frac{43}{100}$
Length on deck	203 feet 7 inches
Breadth of deck	31 „ 9 „
Depth of hold	22 „ 2 „
Length allowed for engine space	70 „ 7 „
Draught, mean, one-half of coals consumed	16 „ 10 „
Area of midship section at mean draught	520
Displacement at mean draught	2,050 tons
Kind of engines	Side-lever
Collective H.P., nominal, per Admiralty	403
Cylinders, diameter	72½ inches
Stroke of piston	6 feet 10 inches
Diameter of paddle-wheel over floats	27 „ 9 „
Number of floats on one wheel	21
Dimensions of floats	8 ft. × 2ft. 10 in.
Kind of boilers	Flue (4)
Number of furnaces	12
Grate, 6 ft. 2 in. × 3 ft.	222 square feet
Total heating surface in boilers	2,698 „ „
Coals consumed outwards to Boston viâ Halifax	440 tons
„ „ homeward from „ „ „	450 „
Mean draught of water, ship leaving Liverpool	17 feet 2 inches

inhabitants of that city, at their own expense, cut her through the ice into clear water for a distance of seven miles. (See illustration, page 182.)

In 1844, Mr. Cunard brought into the service (partly in pursuance of his contract) the *Cambria* and *Hibernia*, each of 500 horse-power, and of 1422 tons, with an average speed of $9\frac{1}{4}$ knots.

In 1848, the *America*, *Niagara*, *Europe*, and *Canada* followed, so as to meet the increasing wants of the trade and the ever increasing demands of the public for greater speed and improved accommodation. Each of these vessels was about 1820 tons and of 680 horse-power, with an average speed of $10\frac{1}{4}$ knots an hour.

The success of the Cunard Company, created, as might have been anticipated, much jealousy among the shareholders of the *Great Western* Steam-ship Company, who complained of a monopoly having been granted to their injury and to that of other owners of steam-ships engaged in the trade, or who were desirous of entering it. Although no unfairness was alleged against Mr. Cunard and his partners, and no valid charges could be raised against the manner in which the mail services were performed, the *Great Western* Company had sufficient influence to obtain a parliamentary inquiry. They asked it, first, on the broad grounds (which have since been frequently raised, and now with much more show of reason than then), that the public was taxed for a service from which one company alone derived the advantage, and which could be equally well done and, at less expense, if mails were sent by all steamers engaged in the trade, each receiving a certain amount of percentage on the letters they carried; and, secondly, because

their company had been the first in the trade and had incurred great expense and risk in developing steam communication between Great Britain and the United States of America. But, after full inquiry, the committee reported that the arrangements concluded with Messrs. Cunard, Burns, and MacIver, were on terms more advantageous than any others which could then be made, and that the service had been most efficiently performed.[1]

Indeed, it was clearly shown that even the first boats the Cunard Company ran between England and America were superior in power and speed to any others similarly employed,[2] and this superiority they long maintained. In the calculations made of the relative power of the steam-vessels thus employed, an average westerly passage across the Atlantic was taken, and an endeavour made to place these vessels in the order of speed. The *Oriental* and *Great Western* were pronounced about equal, as also the *President*, and the *Great Liverpool* before the alterations

Comparative results of different vessels.

[1] Report of Committee of House of Commons, August 1846.

[2] Vessel's Name.	Tonnage.	Horse-Power.	Proportion of Tonnage to Power.	Remarks.
Acadia (Cunard Company)	1,136	400	1 h.p. = 2¾ tons	Exceedingly fast.
Oriental . . .	1,670	440	1 h.p. = 4 „	10¼ knots when deep on trial trip.
Great Western .	1,340	450	1 h.p. = 3 „	
Great Liverpool .	1,543	464	1 h.p. = 3⅓ „	
British Queen .	2,016	500	1 h.p. = 4 „	Fast when light, and light stern breeze.
President . .	2,366	540	1 h.p. = 4½ „	Slow under any circumstances.
Liverpool (before alterations)	1,150	404	1 h.p. = 2½ „	Slow and crank.

See Fincham's "Naval Architecture."

were made in her. It should however be remarked that, though the proportion of power and tonnage was the same in the case of the *Oriental* and *British Queen*, it was not questioned that, on every point, especially when the vessels were deeply laden, the *Oriental* had the advantage. It may also be mentioned that the *Liverpool* was, after her alterations, 393 tons larger than formerly; and, though her proportion of power was consequently diminished, her speed and weatherly qualities were materially increased,[1] showing that more depended *on the form and construction of the vessel* than on having a large engine power.

Building (1839) and loss (1841) of the *President*.

The *President*, built by Messrs. Curling and Young for the British and American Steam Navigation Company, was launched on the 7th December, 1839, with great *éclat*, but her career at sea was very brief, and her end most melancholy. It may be summed up in the few words that, when due from New York, in April 1841, she did not make her appearance; tremendous weather having been experienced in the Atlantic, with unusual quantities of ice in very low latitudes, the most intense anxiety arose both in the mercantile world and among the relatives of the passengers as to the cause of her detention. The arrival of other ships from the same port increased the public anxiety. For a considerable period the appearance of every large vessel was hailed as the missing steamer, and a thousand rumours prevailed as to her wreck in various parts of the world. The hopes long entertained that her engines had broken

[1] Letter from E—— in the *Civil Engineer and Architects' Journal*, January 1841.

down and that she had sailed for the West Indies or elsewhere to refit, proved fallacious, while the agony of the parties interested in her was kept alive by the most conflicting speculations as to the cause and certainty of a catastrophe. The *President* was never again heard of, nor was any trace of her wreck ever discovered. This calamitous event, however it affected the interests of the company of Bristol merchants to whom she belonged, did not check the ardour of the people of England for steam navigation across the Atlantic.

The *Great Western* Steamship Company having, so far back as 1838, resolved to build a second ship much larger than their first, aimed at realizing in her the greatest improvements the art of naval construction could then command. Nor were they disappointed in their expectations, the *Great Britain* when launched being not merely much the largest, but also the finest vessel up to that period built for ocean steam navigation.[1]

Building of the *Great Britain* iron-ship, 1843.

In proportion to all other vessels hitherto constructed of iron, the dimensions of the *Great Britain* were altogether colossal and, at the time, she excited quite as much public interest as that vast leviathan, the *Great Eastern*, did at a later period. She was built at Bristol, and her lines were furnished by Mr. Patterson of that place, who had planned and constructed the *Great Western*. Nor was the public interest

[1] She was constructed of iron, and expressly for the Transatlantic trade. Her dimensions were, length of keel, 289 feet; 296 feet between the perpendiculars; and 322 feet over all. Her extreme breadth, 51 feet, with 32 feet 6 inches depth of hold, her main load draught of water being 16 feet; and her measurement 2984 tons, with engines of 1000 horse-power.

in her at all lessened when it became known that, though originally intended for a paddle-wheel steamer, her builder had boldly resolved to adopt the screw, then comparatively little known as a means of propulsion.

Advantages of iron ships.

As there were still many unbelievers in the suitability of iron, for the construction of sea-going vessels, and still more who had no faith whatever in the value of the screw, this second step in advance on the part of the directors of the *Great Western* Steamship Company led to much discussion among scientific men, and created many evil forebodings as to the ultimate fate of the *Great Britain*, all of which she, however, falsified. On her passage from Bristol to the Thames, though she encountered very severe weather, she braved the storm in a manner (see following illustration,) which ought to have silenced for

STEAMER "GREAT BRITAIN" OFF LUNDY ISLAND.

ever the opponents of iron as a suitable material for the construction of vessels of every description, as well as those men of science who still, and for many years

afterwards, maintained that the screw, under all circumstances, was an inferior motive power to that of the paddle-wheel.

So great, indeed, was the interest felt in this vessel that, on her arrival in the Thames, Her Majesty and Prince Albert with great numbers of the nobility, and thousands of other persons, paid her a visit. Nor was her fame confined to England, forming as she did the subject of discussion among the learned and scientific societies of Europe, which was taken up with unusual fervour in the United States of America when it became known that she was to be employed as one of the Transatlantic steamers destined to eclipse the still celebrated American sailing clippers.[1]

Though the Americans continued with undaunted courage their lines of sailing packets, every year, increasing their dimension, and improving by every possible means their speed and seagoing qualities, they saw the most valuable portions of their trade (first-class passengers and fine goods) passing into

[1] The *Great Britain* was launched on the 19th of July 1843. The machinery was constructed in the works of the company, as no engineers could be found willing to undertake the task by contract. But, by putting the engines into the vessel at the works, it was found that she was so deeply immersed as to be unable to pass out of the dock, and she was, consequently, detained for some months until the requisite alterations could be made for her release. Soon after her experimental trip, made on the 12th December, 1844, she was placed on the American station. Her career, however, was prematurely brought to a close by an accident (stranded on the coast of Ireland) which, though occasioning a serious loss to her enterprising owners, proved at this early stage the great strength and value of iron ships. During the whole winter that she lay on the beach at Dundrum Bay, coast of Ireland, she sustained very little injury, and though frequently altered and under repair since then, the *Great Britain* is still successfully employed in the trade between Liverpool and Australia, and to all appearance is as sound a vessel as she was when launched thirty-one years ago.

the hands of British steamers. Resolving if possible to maintain their position, they, with that genius, and ready adaptation of means to an end peculiarly their own, fitted a steam-engine into one of their sailing-vessels, and were therefore the first to apply the auxiliary screw to ocean navigation, as they had been the first to cross the Atlantic with steam.

American auxiliary screw steamer *Massachusetts*, 1845.

They knew that when the wind was strong and favourable, their celebrated ships could, with their sails alone, surpass in speed any ocean steamers then afloat, and they thought that if they could introduce, at a moderate cost and with comparatively small current expenses, a steam-engine to propel their sailing-packets when the wind failed, or when entering port or passing through narrow channels, they would be enabled to hold their ground against their now formidable rivals. Consequently, they sent forth, in the autumn of 1845, their auxiliary steam-packet ship *Massachusetts*,[1] of which the following is an illustration.

[1] Mr. R. B. Forbes, of Milton, Massachusetts, in forwarding to the author the lithograph of his ship, remarks: "The lower yards and the topgallant yard are in the same position as in the ordinary rig; but the topsail and topgallant sail are so divided as to make three sails instead of two. The topsail being exactly of the size of an ordinary double reefed topsail, the yard being parrelled to the heel of the topmast, where the topmasts are fidded forward of the lower mast-head; and to the head of the lower mast where the topmasts are (as they ought to be) fidded abaft the mast-head; this renders it necessary to have the lower mast-heads longer, by several feet, than in the old rig. The next sail above the topsail, representing the upper half of the topsail of the old rig and a fraction of the old topgallant sail, is called the topgallant sail, and the old rig topgallant sail is in the new rig called the royal, while the royal of the old rig becomes the skysail of the new rig. As I consider it important to have the sail as much in the body of the ship as possible, and at the same time to dispose of the canvas and spars that the sails can be used in

From a description given of her in the *Mechanics' Magazine* of January 1846, she appears to have been 161 feet in length on deck, 31 feet 9 inches in breadth of beam, and 20 feet depth of hold from maindeck.

AUXILIARY SCREW-STEAMER "MASSACHUSETTS."

She was 751 tons, O.M., and had a full poop extending to the mainmast, in which there was accommodation for thirty-five first-class passengers.

Her enterprising owners (Mr. Forbes and others),[1] did not contemplate competition so far as regards

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different places, I make the foreyard of the same length (excepting a slight difference in the yardarms) as the main topsail yard; the fore topsail yard the same as the main topgallant yard, the fore topgallant yard the same as the main royal yard, and so on with the mizen, so that the yards and sails on the fore fit on the main one stage higher up, those on the mizen fit on the fore one stage higher and on the main two higher."

[1] In a letter which I had the pleasure of receiving from Mr. Forbes (November 1874) that gentleman further remarks: "On the 15th

speed with the steamers then employed on the Atlantic service, but by using the screw as an auxiliary they hoped to accomplish the voyage with so much greater rapidity than an ordinary sailing-ship as to recompense them for the cost of the machinery and the cargo space which it occupied. By insuring greater regularity they also hoped to command a moderate share of the passenger traffic, and of that description of goods which from their nature would not allow so high a rate of freight to be paid as the owners of steam-ships required to cover the greatly enhanced cost of navigation. The passages of the *Massachusetts*, as compared[1] with those of sailing-ships which left Liverpool before and after her, showed a considerable saving in time.

Her motive power consisted of a condensing engine, constructed by Messrs. Hogg and Delamater of New York, designed by Captain Ericsson and fitted with

September, 1845, I sailed for Liverpool in the steam-propeller ship *Massachusetts*: she made one other voyage to that port and, in June 1846, she was chartered to carry troops to the Gulf of Mexico. She was afterwards bought by our government and bore the flag of General Scott to the siege of Vera Cruz. She long continued in the navy department, and was known as the *Farralones*. Three or four years ago our government sold her when her machinery was removed, and she is now running and is called the *Alaska*."

[1] Name.	Date of Sailing.	Date of Arrival.	At	Advantages to credit of *Massachusetts*.
Massachusetts . .	Oct. 22	Nov. 18	Holmes Hole	*
Shenandoah . .	Oct. 22	Dec. 3 a 4	Sandy Hook	13 days
Adirondack . .	Oct. 22	Dec. 3	Sandy Hook	13 days
Henry Clay . .	Oct. 23	Nov. 26	Sandy Hook	5 days
Columbiana . .	Oct. 23	Nov. 30	Boston	11 days
St. Patrick . . .	Oct. 23	Dec. 1	New York	11 days
St. Petersburg . .	Oct. 13	Nov. 27	Boston	18 days

his screw, the blades of which turned up out of the water when the vessel was under sail alone. The engine had two cylinders working nearly at right angles, each 3 feet stroke and 25 inches diameter. There were two boilers, named "waggon-boilers," each 14 feet long, 7 feet wide, and 9 feet high, with a furnace to each boiler. For the purpose of raising steam quickly there was a blowing-engine and blower, the power of her engine being equal to 170 horses, sufficient to drive the ship about 9 statute miles an hour in smooth water and during calms, with a consumption of 9 tons of anthracite coal per day. The whole of the machinery, with the boilers, coal bunkers, &c., which were fitted in the after portion of the lower hold, occupied a space of one-tenth the cubic contents of the ship. Her propeller was made of composition metal, and could be raised out of the water when the steam-power was not required. Its shaft passed through the ship, close to the stern post on the port side and rested in a socket which was bolted to the stern post, and further supported by a massive brace above. Her entire cost was 16,000*l.* complete in all respects with machinery.

But even the *Massachusetts*[1] did not meet the wishes

[1] Mr. Forbes, one of the owners of this ship, is a remarkable man, and has, during the long period of sixty years, taken so useful and active a part in the development of the maritime resources of his country, that a brief note of his career, for which he has furnished the materials, cannot fail to interest my readers. In 1811, when a boy of only seven years of age, he and his mother were captured at sea on their passage to France, and, again, in 1813, on his return passage. In 1817 he adopted the sea as a profession; and by his genius and industry he obtained the charge of an Indiaman, before he had reached the age of twenty years, and by 1830 he was in command of a ship of his own

of the American people. They saw their most valuable maritime commerce slowly but surely passing away from them, and though not yet prepared to run steamers to compete on the direct Atlantic line with British enterprise, they determined to secure at least a portion of the first-class passenger and fine goods trade with Europe. Consequently, they established a line of steam-ships of their own to run between New York and Bremen, calling at Southampton,

American line of steamers to Europe, 1847.

engaged in the trade with the East. He retired from the sea in 1832, and, in 1839, he became the principal partner in one of the largest mercantile establishments in China—the still well-known house of Russell and Co. In November 1844 his *Midas* (propeller schooner) left New York for China: she was the first American steam-vessel that went beyond the Cape of Good Hope, and the first to ply on the waters of China. He was also interested in the propeller barque *Edith*, which left New York for Bombay and China, on January 18th, 1845. She was the first American steamer despatched to British India, and the first square-rigged propeller to China under that flag. In April 1845 he, with others, built an *iron* paddle-wheel steamer, nearly 300 feet in length, which they named the *Iron Witch*: she was designed by Ericsson for great speed, to ply on the River Hudson, but as she did not prove fast enough to compete with the regular Albany boats, her engines were transferred to a wooden vessel named the *Falcon*; the *Falcon* was the first American steamer that plied to Chagres in connection with the California route, as the *Iron Witch* had been the first iron passenger steamer that plied on the North River. In 1845 Mr. Forbes launched the first iron steam-tug, built for mercantile purposes in New England, designed so far back as 1838. In 1847 he loaded the ship *Bombay* with a full cargo of ice for Bombay, the first cargo taken there, a small quantity having previously gone in the *Paul Jones* in 1843. At that period it used to be a joke that the Americans had nothing to offer in return for the produce of India except *ice*, apples, and bills! On the 28th of March, 1847, he sailed from Boston to Cork in the sloop of war *Jamestown* with 800 tons of provisions, nobly contributed by citizens of Boston and other inhabitants of New England for the famine-stricken Irish—an act in itself which constituted a grand and imperishable monument of their goodness. In 1847 he sent to China on the deck of a ship, a small iron propeller called the *Firefly*, the first vessel of the kind to ply on the Canton river. He states that when in China in 1839–40, he sent the first cargo of tea to England in an

and in June 1847 started their first ship, the *Washington*, for Southampton on the same day that the *Britannia*, belonging to the Cunard Company, sailed from New York for Liverpool. This was the first race between American and British steamers, and though the *Britannia* did not require "to run by the deep mines, and put in more coal" to beat the *Washington* as the *New York Herald* anticipated, the other prophecy of the editor of that enterprising journal has been now remarkably fulfilled.[1]

First ocean race won by the English.

The *Britannia* won the race by two full days. The *Washington*,[2] of which the following is an illustration (though the Spithead correspondent of the

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American ship, the *Oriental*. In 1857-8 he built and despatched from Boston, an iron paddle-wheel steamer, called the *Argentina*, of 100 tons for the survey of the La Plata, which ascended the Parana beyond where any steamer had previously navigated. In 1861 he despatched the iron propeller *Pembroke* for China, where she was sold. She held the only "letter of marque" issued by the United States' Government during the great civil war. Such are a few of the leading points in the active life of Mr. R. B. Forbes, of whom his country may be proud, who still in his fresh old age continues his career of usefulness. He now builds boats for the "good boys" of his native town, and I had great pleasure in executing for him the other day an order for no end of miniature blocks, dead-eyes, anchors, and cables.

1 "We have to say that, if the *Britannia* beats the *Washington* over (and they both, we understand, start the same day), she will have to run by the deep mines, and put in more coal. We shall have, in two years' time, a system of Atlantic, Gulf, and Pacific steamers in operation that will tell a brilliant story for the enterprise of Brother Jonathan. We are bound to go ahead, and steam is the agent of the age. We expect yet to see the day when a traveller will be able to leave New York, and going eastward all the time, will be enabled to make the circuit of the earth, coming in by Huascualco, in the summer interval between two sessions of Congress, spending a month or two in the Mediterranean on the way."

2 "The *Washington* is stated to be of 2000 horses' indicated power, and is 1750 tons Government measure, or 2000 tons carpenters' measure; so her steam power is to her tonnage as one to one, while the *Britannia*

STEAMER "WASHINGTON."

London *Times* does not give a very glowing account of her appearance as she passed before him on the

has only one horse-power to 2¾ tons.* To go a little, however, more into detail: both vessels have two cylinders, I believe, of the same diameter, viz., 72 inches, and both have side beam engines; the stroke of the *Washington* is 10 feet; her boilers are able to carry (they say) 30 lbs. of steam; but, if we allow her only 23 lbs. × 13 vacuum, she will be still double the power of the *Britannia* with 5 lbs. × 13 lbs. *i.e.*, = 900 horses' power (450 × 2). I am now speaking of full steam, or at least both cutting off at the same point. The *Herald* (New York) says the *Washington's* wheels are 39 feet in diameter, and 7½ feet dip; but the latter is of course an error, and probably means 7½ feet face; she has two boilers 36 feet × 15 on the plan; there are three furnaces, each 7 feet × 4 feet 6 inches × 6 = 189 feet. Well then, there you have data from which you may calculate how many horses' power can be got off that great surface with anthracite and blowers. Her recipient heating surface must be large; she has flues, perhaps 12 inches in diameter."

* The proportion was actually one to two as against one to two and three-quarters.

waters of the Solent[1]), was welcomed on her arrival at the port of Bremen with great rejoicings; the burgomaster proceeding on board in state to invite the captain to a banquet in the Town Hall, specially prepared for him by the Senate.

Hitherto the American Government had been opposed in principle to all subsidies, but the vast results which accrued to the material interests of the United States from the extensive employment of steam navigation, effected concurrently a great change in the policy of the Federal Legislature and soon rendered it necessary to subsidize vessels of their own for the conveyance of their mails to Great Britain. If, before the period of the introduction of steam, Congress had exhibited an undue parsimony in providing funds in any form for their national navy, it is certain that a more liberal policy now prevailed.

Ocean steam navigation was now adopted by the Americans for the joint purpose of extending and advancing the commercial and other interests of the country, and more especially to provide a marine force which might be easily made available for the protection "of American rights;" and the attainment of this two-fold object was the motive which, in the opinion of Congress, justified the application of public

Not satisfied with the Cunard line, the Americans determine to start one of their own.

[1] "In point of size she looked like an elongated three-decker, with only one streak round her; but about as ugly a specimen of steam-ship building as ever went through this anchorage. She did not appear to make much use of her 2000 horse-power either, but seemed rather to roll along than steam through the water. She excited considerable curiosity, although her performance, as compared with the *Britannia*, had evidently taken the edge off the feeling with which the vessel would have been viewed had a different result been obtained in her favour." (Spithead correspondent of the *Times*.)

funds in aid of private enterprise. Nor was the argument, once so popular in England, overlooked that the money so advanced would ultimately be reimbursed by saving the expense of a standing fleet to the extent of the number of the vessels subsidized in the conveyance of the mails, while encouraging commerce and the arts during the time of peace.

The Americans also now complained (they had not thought of it before) that the ocean mails along their southern coasts had been placed in the hands of foreign carriers,[1] sustained and protected by the British Government, under the forms of contracts to carry the British mails; while the Cunard line, between Liverpool and Boston viâ Halifax, constituted the only medium of regular steam navigation

[1] In 1840 and 1841 the British Government entered into contracts, to which I shall hereafter refer, for the conveyance of the mails with the West Indies and also with the Pacific Steam Navigation Companies; and, early in 1850, they concluded a contract with the Cunard Company for the conveyance of the mails between Halifax, New York, and Bermuda in small vessels of 350 tons and 80 horse-power, fitted with a proper space for mounting an 18-pounder pivot gun. One of these vessels left Halifax for Bermuda and another left for St. John's within twenty-four hours after the arrival of the packet from Liverpool; a third conveyed the mails monthly between Bermuda and New York, the subsidy being 10,600*l.* per annum, or at the rate of 3*s.* per mile; on the main line it was 11*s.* 4*d.* per mile.

In 1851, the British Government made another contract with the Cunard Company for a monthly conveyance of the mails between Bermuda and St. Thomas each way upon such days as might be fixed by the Admiralty, the provisions as regards the size, power, and armament of the vessels being the same in all respects as those in the other subsidiary service, only that the price was to be equal to 4*s.* per mile, or 4,100*l.* per annum. This service connected the West Indies with the United States and the North American provinces. The departure of the one vessel engaged in it took place immediately after the arrival of the homeward mail West India packet, so that she carried the correspondence of the West Indian Colonies and of Her Majesty's officers on the station from that island to Bermuda.

line of sailing packets between Liverpool and New York. To ensure the most perfect description of vessels, he nevertheless sought the assistance of the most competent shipbuilders and engineers, who had not only the proper knowledge of marine engines and boilers, but who, having also seen their operation at sea, would be able to avoid previous errors, and to construct vessels and machinery well fitted to vie with the best that England could produce.

When, therefore, Mr. Collins and other American citizens, who had associated themselves with him, offered to enter into a contract with their Government for the conveyance of its mails between New York and Liverpool, their proposals were favourably entertained and, in the sequel, an agreement was entered into with them to perform twenty voyages in each year, with five first-class steam-vessels; for which important services Mr. Collins and his colleagues were to receive $19,250 per voyage.

Original terms of subsidy.

Immediately the contract was completed, arrangements were entered into for the construction of four such vessels, to be named the *Arctic*, *Baltic*, *Atlantic*, and *Pacific*, each to be about 3000 tons register and of 800 horse-power.

These vessels, built chiefly of live oak, were planked with pitch pine and were in strength equal, if not superior, to any vessels constructed of wood then afloat. The timbers, which were solid and bolted to each other, were further strengthened by a lattice work of iron bands, wood and iron being so united as to derive the greatest advantage from each: wood for its elasticity, and iron for its greater power of resistance. They were beautiful models, and could

Dimensions of their steamers

at a small expense have been easily converted into ships of war. The *Arctic*, which was considered the finest of the fleet, familiarly known as the "clipper of the seas," was built by Mr. William H. Brown of New York, under the superintendence of Mr. George Steers, who modelled the famous yacht *America*. She was 2856 tons register.[1] Her equipment was complete and of the highest order, as I can testify from inspection, while her cabin accommodation in comfort and elegance surpassed that of any merchant-vessel Great Britain then possessed.

"To enter," exclaims Mr. Bayard, a member of the Senate, "the contest with England for the supremacy of ocean steam navigation required talent, energy, and *faith* of the highest order known to our countrymen, for to *fail* would involve a loss not only of the vast sums necessary to make the effort, but, what is of far more value to every lover of his country's reputation, it would insure national disappointment, more deeply felt from the fact that England had already been vanquished by our sailing-ships, and gracefully yielded to us the palm of victory, since more brilliantly illuminated by the

[1] The general dimensions of these celebrated steamers were: length of keel, 277 feet; length on main deck, 282 feet; depth from the maindeck, 24 feet; depth under the spar dock, 32 feet; breadth of beam, 45 feet. They had rounded sterns, three masts with suitable spars; a lower deck, main deck, and spar deck, as well as an orlop deck extending from the engine-room forward and aft. The area of transverse section of the *Arctic*, for instance, was 772 square feet. Launching draught aft, 10 feet; average displacement per inch, from launching to load line, 20½ tons; area of load line, 9369.10 square feet; whole displacement to its circumscribing parallelopipedon, 601 per cent.; weight of hull, 1525 tons; weight of spars and rigging, 34 tons; ordinary load line aft, 20 feet; ordinary load line forward, 19½ feet.

yacht *America*, and the clipper ship *Witch of the Wave.*"

Such were the expectations and warnings of those who guided public opinion in the United States, when it was resolved to undertake this great ocean race.

Before giving out the contracts for the machinery, Mr. Collins obtained from Messrs. Sewell and Faron, chief engineers of the United States' Navy, full specifications of the engines and boilers the latter had designed, and subsequently made use of, for the steamers *Arctic* and *Baltic*.[1]

At that time it was believed, from the best information that could be obtained, that the Cunard steamers carried an average boiler pressure not exceeding 10lbs. to the square inch, and that, to equal them, it would only be necessary to have for the Collins vessels, cylinders of 90 inches diameter and 9 feet stroke with the same boiler pressure, although Mr. Sewell (it is understood) originally advocated 95-inch cylinders. After the contracts were given out to the Novelty and Allaire Works of New York, Mr. Collins procured permission of the government to allow Mr. Faron to visit Great Britain and examine the marine engines and boilers in use there. On his return in the *Niagara*, he discovered that the safety-valves of that steamer were weighted with 13lbs. per square inch, and that with every plunge of the vessel, the valve would open slightly, at once indicating the pressure

Mr. Faron's visit to England.

[1] I have not room for these very valuable historical documents, so much wanted in our own merchant navy, but the reader interested will find them *in extenso* in note, Appendix O, in Mr. C. B. Stuart's work, "On Naval and Mail Steamers;" U.S., published in New York, 1853.

was equal to the load on the valve. The moment this was communicated to Mr. Collins, he conveyed the intelligence to his engineers, giving a cross section of the *Niagara* and the dimensions of her cylinder, with 13lbs. of boiler pressure, together with the cross sections of the *Atlantic*, and the

STEAMER "ATLANTIC."

Pacific then building. The engineers accordingly recommended that, to *equal* the Cunard vessel, the dimensions of the cylinder should be 95 inches diameter and 9 feet stroke, the size originally suggested by Mr. Sewell, to which Mr. Collins at once agreed. The engines of the *Arctic*, like those of her sister vessels, were of the "side-lever" kind, with solid cast iron beams, and wrought iron columns and braces. The cylinder, air pump, feed-pumps, shaft-bearing columns, &c., rested upon the bed-plate; the ordinary parallel motion was used to guide the

Details of the build of these vessels.

piston-rod, as in the British engines, and the motion was communicated to the cranks by the ordinary arrangement of cross-head, cross-tail, side-rods, and single connecting-rod.

The most essential difference from the British method was in the steam and exhaust valves, which were of the "balance poppet" variety, the steam valve being also used for expansion, and working in the several vessels, under the following patents:—on Allen's cut-off in the *Arctic* and *Atlantic*; Stevens's in the *Pacific*; and Sickles's in the *Baltic*. These engines were greatly admired at the time.

The *boilers* of the *Arctic* were peculiar to the Collins line, and their merit was principally due to Mr. Faron, who acted as chief engineer of the company. They were arranged with double furnaces, and lower water-spaces connected by a row of vertical tubes, around which the heated gases circulated, with a hanging bridge or plate, which checked their otherwise rapid flow to the chimney and rendered the combustion more perfect. The heating surface was principally confined to the tubes and consequently vertical, the height of the smoke-pipe above the grates, 75 feet, insured a strong natural draft, and the proportion of heating to grate surface, was unusually large, being 33¼ to 1. The ratio of evaporation of sea water, during the quick trip of the *Baltic* in February 1852, was 8·55 pounds of water per pound of anthracite.[1]

Mr. Collins, under the advice of his engineer, originally intended to use fresh water entirely in

[1] A description in detail of these boilers is given in the note, Appendix O, already mentioned.

these boilers, previously condensed from sea water, and an arrangement was made with J. P. Pierson, the inventor of the "double vacuum condenser," to furnish condensers. But the tubes, which had been manufactured in England, were lost at sea, and the vessels were equipped without them.

Bituminous coals alone were used until the superior qualities of anthracite were in several particulars shown to be of great importance in ocean steamers, when it was determined to use the former only *on the return trips;* and such became the established practice, resulting from an extended and careful series of experiments.[1]

The *Pacific* was a three-decked ship, very high on the water, and consequently much more comfortable for passengers than the other vessels; while the straight line of her bows, and freedom from encumbrances on her upper deck, offered less resistance to the wind. Her model under the water-line resembled somewhat the river boats; she had a flat bottom, her immersed section being not far from a parallelogram. Her bows and stern were formed by nearly plain surfaces, which, joined together, constituted an

[1] The respective diameters of wheels in these steamers from outside to outside of floats, were as follows, viz., *Arctic,* 35 feet 6 inches; *Baltic,* 36 feet; *Atlantic,* 35 feet; and *Pacific,* 35 feet. Those of the *Arctic* and *Atlantic* had thirty-six floats; the *Baltic,* thirty-two; and the *Pacific,* twenty-eight.

The average performances of the engines of the *Arctic* were as follows: pressure, 16·9 pounds; revolutions, 15·8 per minute with an average consumption of 83 tons of anthracite coals per day of twenty-four hours, giving an average speed of 316·4 knots per day. Her maximum pressure was 17·5 pounds; revolutions, 16·7 per minute; consumption, 87 tons, and speed 320 knots per day. The consumption of coal per day in the *Asia* (Cunard line) was, on an average, 76 tons, and her speed with this consumption 303 knots per day.

angle much more acute than was considered safe for adoption in ocean navigation some years ago.

The *Pacific* was provided with two engines, each supported upon a large and solid bed-plate 32 feet long, and 9 feet broad, which was fastened to the keelson and ship's bottom by bolts of large dimensions previously fixed in the wood; it was a single casting having a channel below in which there was a foot valve, and above it the cylinder bottom, the air-pump seat, and also a great part of the condenser, through which the side-lever shaft passed: it also had upon it sockets for the different pieces of the frames. On the cylinder bottom, at the extremity of the bed-plate, the cylinder itself was bolted, the largest at that time ever cast: its diameter being 96 inches, calculated for a stroke of 9 feet, and length, flange to flange, 10 feet 6 inches. The lower steam-opening being cast with the bed-plate, the upper one alone belonged to the cylinder. The steam exhaust valves were on the plan generally adopted in the United States and arranged with Stevens's "cut off," so as to let the steam expand one-half its volume. **Engines.**

The steam passed from the boiler to the upper steam-opening by a large pipe 2 feet in diameter and about twenty feet long, and after doing its duty in the cylinder, escaped by the middle of the exhaust side pipe, and reached the condenser, which was not more than 1 foot distant, through a pipe of the same section.

The condenser and the reservoir were formed by a single casting inside which was a partition between them of the same casting. This piece was ornamented in the same style as the steam-chest, and

supported a beautiful turret used as an air reservoir, which rather resembled an old castle of the Middle Ages than a steam engine of the nineteenth century, and gave an imposing appearance to the whole structure. The steam, arriving in the condenser between two horizontal iron plates, which were pierced over the whole surface, causing the condensing water to fall in small streams through them, so as to be soon condensed; then passing through the foot valve under the condenser, it reached the air-pump, which was situated on the other side of the condenser.

The condenser was so much elevated that the steam required to make a vertical descent of 11 feet, mixed with cold water, before reaching the channel way, thereby furnishing the means of quick condensation with a condenser of comparatively small size. All the pieces of the engine, cylinders, levers, connecting rods, &c., were calculated upon the best rules then known,[1] and the straps, keys, gibs, ribs, mouldings, &c., were so disposed as to produce the maximum of strength and security against accidents: but the pre-eminent success was in the design of the frame.

Frame sustaining engines and dead weight.

Any scientific engineer can calculate the thickness of a cylinder or diameter of a connecting rod necessary to resist the force they have to resist, but the disposition of the frame becomes difficult when the action of dead weight, and the various pressures produced by the working of the engines are complicated through the motion of the ship herself,

[1] The plates of this splendid engine will be found in the second volume of Tredgold's "Steam-Engine," and well deserve the attention of professional readers. Mr. Victor Beaumont's account of the ship and engine will be found in the same volume.

which alters their modes of action. The usual practice had been to sustain the engines by a frame so massive as to present ten times the strength necessary, and accordingly a useless and costly weight took permanently the place of cargo: but in the engines of the *Pacific*, the difficulty was completely overcome: two large hollow pillow-blocks which sustain the paddle-wheel shafts on each side of the cranks were supported in each engine by four wrought iron columns on the forward extremity of the bed plate, the centre of the shaft being 23 feet above the keelson. The pillow-blocks thus supported were connected by two strong inclined braces to the cylinder, by means of solid facings cast with it, on each side of the steam opening. To maintain this skeleton, a number of braces, small in appearance, were so disposed as to effect the purpose.

No expense having been spared to render the ships of the Collins Company complete in all respects, the cost so far exceeded the estimates that the government found it necessary not only to make an advance to the company, while the vessels were in course of construction, but also to relieve them from their obligation of building a fifth vessel as originally contemplated, and to increase the subsidy from \$19,250 to \$33,000 per voyage, or to the sum of \$858,000 (about 178,750*l.*) per annum. *But increased rates of speed were required in return.*

Cost of steamers greatly increased by demand for increased speed.

There seems an almost insane desire for increased speed in locomotion by land and by sea, especially by persons who are not aware, or who do not consider that high speed involves increased danger, and

greatly increased cost in ocean navigation. The attainment and maintenance of high speed depend upon the exertion of a high power. High speed and power require stronger parts in everything: in the materials for the ship's build, the boilers, the machinery, and in all the working arrangements. High speed and power demand a larger outlay in prime cost for the adequate resistance required by such power, and lead to more frequent and costly repairs. High speed and power need more watchfulness, more prompt action, and consequently more persons, whether engineers, firemen, or coal-stokers; moreover, they cause the consumption of more fuel.

These propositions have been evident to all practical men in America, as they must be to those on this side of the Atlantic. In the construction of the hull, greatly increased strength is obviously requisite. The resistance to a vessel, or its concussion against the water at a low rate of speed, will not be sensibly felt, but if that speed be considerably increased, and the concussion made quicker without a corresponding increase in the strength of the frame and hull of the ship generally, the ship will creak, strain, and yield to the pressure until she finally works herself to pieces, at the same time disarranging the engines, whose stability, bracing, and keeping proper place and order depend first and essentially on the stability of the hull. If the resistance to a vessel in passing through the water increases as the square of the velocity, and if, in addition to this outward thrust against the vessel, she has to support the greater engine power within the hull, which has increased as the cube of the velocity, then her strength

must be made adequate to resist without injury these two combined forces against which she has to contend.

The same increased strength is also necessary in the engines and boilers. It is evident that if the boilers have to generate and the engines to employ twice the power and exert twice the force, they must also have twice the strength, and there is no working arrangement in any way connected with the propulsion of the ship that does not partake of this increase: every pump, every valve, every bolt is connected, directly or indirectly, with the engine economy of the ship. All this is equally applicable to the ship's hull, though in a less degree in the case of iron vessels than in those of wood It is unnecessary to dwell upon the cost of repairs: indeed, the rapid motion of heavy parts of machinery and the necessarily severe concussions and jarrings cannot fail to destroy the costly working parts of the engine, entailing heavy and expensive repairs and substitutions.

But first cost and current expenses do not for the moment appear to have been considered by any person interested in the Collins line. One thought, and one only, prevailed, and that thought was embodied in the resolution to run the Cunarders off the Atlantic, or at least to "neutralize," as was expressed in the discussions of the period, "an existing foreign monopoly." The enterprise they proposed "was one of a national character, and the semblance or reality of monopoly on their side was lost," they alleged, in the stipulation of the contractors themselves to transfer their ships at cost price with their contracts, and all the additional facilities that might be extended

to them by Congress "to any person who might be acceptable to the United States' Government, and capable of carrying out an enterprise of such vital importance to the nation."

By this plausible but transparent mode of reasoning Congress attempted to disguise the real features of an undertaking which eventually became a great failure. From the spirit, however, which then prevailed, cost was not considered either by the projectors or by the majority of the members of Congress in their determination to surpass in speed and in splendour of equipment, any steamers which Great Britain could send afloat. "We must have speed," exclaimed Mr. Bayard, "extraordinary speed, a speed with which they (Collins steamers) can overtake any vessel which they pursue, and escape from any vessel they wish to avoid; they must be fit for the purpose of a cruiser with armaments to attack your enemy (if that enemy were Great Britain) in her most vital part, her commerce."

Happily, the Collins steamers were never required for any such purposes, and, in 1850, just ten years after the Cunard vessels commenced to run, they started against them in their great contest for the commercial maritime supremacy of the Atlantic Ocean, a much more sensible struggle than that which Mr. Bayard so glowingly pictured when he spoke about their "sweeping the seas."

Further details of competing lines.

Before the Collins line was established, the Cunard steamers were receiving 7*l*. 10*s*. sterling per ton, freight, which was so much of a monopoly rate, that in two years after the Collins line had commenced, the rate of freight fell to 4*l*. sterling per ton. Arguing

from this fact the Americans held that the excessive freights charged for transport by the Cunard Company were paid by the United States' consumer, in most instances, on articles of British manufacture carried to America by British vessels. But now the American consumer paid only *4l.* per ton, and this sum for the most part was paid to their own people, thus increasing their national wealth. Their acute political economists discovered "that formerly the American consumer paid *very nearly twice as much for the service*, and enriched the British capitalists: whereas, subsequently to 1850, he not only saved one-half of the former cost of freight to himself, but in paying the remaining half, benefited his fellow-citizens who, in return, aided in consuming perhaps the very merchandise which he had imported."[1]

Speed obtained and cost.

Arguments such as these, too frequently honoured with the title of political economy, are often employed to hide direct taxation; so, instead of attempting to refute them, I prefer inviting my readers to inquire with me into the practical results.

Now, there can be no doubt that the Collins line of steamers did honour to the naval architecture of the time, and in their performances equalled the expectations of their most sanguine friends. Mr. C. B. Stuart, with feelings of national pride, places upon record that, in May 1851, the *Pacific* accomplished the passage from New York to Liverpool in nine days, twenty hours, and sixteen minutes, and that, in July 1852, the *Arctic* made the same passage in nine days, seventeen hours, and twelve minutes, which consider-

[1] See Reports of Proceedings in Congress.

ably exceeded in swiftness any voyages hitherto made across the ocean by the vessels of any nation. But while this determination to surpass every other vessel afloat is one which commends itself to our admiration, if not to our better judgment (as speed unless it is combined with safety should always be condemned), it was attended with enormous extra outlay, for, by a statement afterwards laid before Congress, it appeared "that to effect a saving of a day or a day and a half in the run between New York and Liverpool costs the company nearly a million of dollars annually."[1] So eager, however, are the public to make rapid passages (and this applies to railways as well as ships) that the Collins line for the time had a decided preference with passengers.[2] Nor was there any lack of valuable goods; the gross earnings of the company by freights and passage money alone amounting in the two first years to \$1,979,760. But while the Government during these two years paid the Collins line for mail service \$770,000, they only recovered \$513,546, showing a pecuniary loss of \$256,453, so that, so far as the

[1] The comparative cost of driving a steamer on the average of 7 knots up to an average of 9 knots is very small compared to what it would be to increase the speed from 9 to 11 knots an hour, and it becomes enormous when that rate is increased (as the resistance increases with the square of the velocity), but my readers must take the very large sum mentioned as the extra cost of one extra day's saving of time with *very considerable qualifications*, as the statement was made in Congress with the object of obtaining for the Collins line further assistance either in the shape of a vote of money or an enhanced annual subsidy.

[2] From a return which appeared in the *New York Herald* on the 1st of January, 1853, the number of persons carried in the course of eleven months, January to November inclusive, 1852, was:

By Collins line to Liverpool, 2,420, to New York, 1,886.
By Cunard line to „ 1,783, to „ 1,186.

public was concerned, the establishment of the Collins line of steamers can only be regarded as a costly and doubtful experiment; and, as will hereafter be shown, the establishment and maintenance of a costly Transatlantic line was not merely an equivocal success on the whole, but to the shareholders resulted in a vast loss of capital.

The owners of the Cunard steamers were, however, not listless spectators of the great preparations which the Americans were making to run them off their ocean lines, and, in 1850, they added two new vessels to their fleet, the *Asia* and *Africa*; they were sister ships[1] but, though magnificent vessels, they were not Great competition, 1850–1852.

[1] The dimensions of the *Africa*, built of wood by Messrs. Steele and Company, of Greenock, were as follows:

Builders' Measurement.	Ft.	In.
Length of keel and fore rake	267	0
Breadth of beam	40	6
Depth of hold	27	6
Tonnage . . . 2128 78–94ths		
New Measurement.		
Length on deck	265	0
Breadth on ditto at midships	37	2
Depth of hold at ditto	27	2
Tonnage . . . 2226 24–100ths		

She had a pair of side-lever engines, by Robert Napier of Glasgow, of 814 horse nominal power. Diameter of cylinders, 96 inches by 9 feet stroke; paddlewheels, diameter, extreme, 37 feet 7 inches, and 30 feet 10 inches effective; twenty-eight floats, 9 feet 2 inches by 3 feet 2 inches, three sets of twenty-eight arms, eight floats in the water at 19 feet draft of water. Four flue boilers, twenty furnaces; bunkers to hold 890 tons of coals; thirty-eight hands in the engine-room. The *Africa* was built of the best British oak, and planked double outside and inside, and the space between the frames was filled up, from the keel to the gunwale, with rock-salt, to preserve the vessel from the dry rot. The number of her berths enabled her to carry 180 passengers. She was manned by a full crew of chosen men, giving about one-third to each department. She was estimated to carry 900 tons of coal; and

equal in speed to those which the Collins Company had sent forth.

The competition between these two great lines of steam-ships excited extraordinary public interest at the time on both sides of the Atlantic, and indeed in all parts of the world; numerous records were kept for twelve months of the length of the respective voyages of the ships of the contending companies, and large sums of money were expended in bets on the result of each passage. Dividing the year into two parts it appears that the average length of passage from Liverpool to New York of the Collins steamers during the last half of 1851 was eleven days eighteen hours, while the average time of the Cunard boats was eleven days, twenty-three hours, thirty minutes; but, in the last quarter of that year, they were respectively, on the return passages from New York to Liverpool, ten days, twenty-three hours, and ten days, thirteen hours, seventeen minutes.

Results of it.

During the first half of 1852, the Collins line made the passage from Liverpool to New York, on an average of eleven days, twenty-two hours, and the Cunard Company on an average of twelve days, thirteen hours, and fifty-two minutes, while the return passages to Liverpool were respectively eleven days, one hour, and ten days, twenty-one hours, forty-four

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she had capacity for the transit of 600 tons of cargo, not including the stores of ship and passengers. Fitted up for carrying guns, the *Africa* could at any time be transformed, from the peaceful original, into an Admiralty ship of war. The saloons and berths were fitted with an evident regard at once to elegance and utility: there was nothing the most refined taste could desiderate, as there was nothing wanting which could add to the comfort, convenience, and pleasure of the passengers.

minutes, showing, on the whole, an average gain each passage of fourteen hours, twenty-three minutes, in favour of the Collins line.[1]

It must, however, be mentioned that the Cunard line had only two of their new, or best boats engaged in the race, and that had their old boats, the *Canada*, *Niagara*, and *Europa*, been equal in speed to the *Asia*[2] and *Africa*, the gain of the Collins line would have been reduced to nine hours and ten minutes each passage. Still, in that great ocean race, the Americans were triumphant, and the rejoicings which spread throughout the United States, were, to our credit, re-echoed on the shores of Great Britain, for the struggle was one which, up to that time, had involved no loss of life, and the triumph honestly gladdened the hearts of every lover of progress on both sides of the Atlantic, encouraging as it did two great nations to extend the benign influence of art and science to their legitimate object—the advancement of the human race.

But though the Cunard Company were thus far behind in the contest, they were far from vanquished,

[1] See Appendix No. 8, p. 601. I give the authorities from whom these returns were obtained, and all the figures on both sides of the question, so that my readers may judge for themselves, but, having had the log-books of the Cunard Company examined with great care, I can vouch for the accuracy of the conclusions in my text.

[2] Mr. C. B. Stuart computes the power of the *Asia* at eight hundred and sixteen H.-P., and the *Atlantic* and *Pacific* at only eight hundred each. On further comparing these steamers it will be found that for each square foot of immersed section the *Atlantic* had $1\frac{10}{100}$ horse-power; the *Pacific*, $1\frac{12}{100}$; and the *Asia*, $1\frac{28}{100}$, thereby giving the latter an important advantage over the others. In the judgment of the Americans, therefore, whatever superiority may have been exhibited in their vessels over those of the British in speed, is justly ascribed to their models, effective boilers, and ability in their preparation.

and, with renewed exertions and indomitable energy, at the same time ever bearing in mind the value of human life and the stupendous responsibility they incurred in the continuation of this struggle, they, as will hereafter appear, produced steamers which surpassed their competitors in speed, and were unrivalled in the regularity and safety with which their passages were performed. It was far otherwise with the Collins Company, and the closing years of their brief career is a sad, sad story to tell.

CHAPTER V.

Dangers of Atlantic Navigation—Collision of *Arctic* and *Vesta*, 1854—*Arctic* founders—Loss of *Pacific*, 1856—Renewed exertions of the Collins and, also, of the Cunard Company—Launch of the *Persia*—Collins line relinquished, 1858—*Scotia*—Her great strength and speed—*Russia*, first Cunard iron screw-steamer, 1862—*Bothnia* and *Scythia*, 1874—Their construction, outfit, and cabin accommodation—Vessels now owned by Cunard Company—Comparison of *Britannia* and *Bothnia*—Cunard Company never lost a life nor a letter during thirty-five years—Reasons—Value of punctuality—Admirable discipline in their ships—Regulations of the Company—Most disasters may be prevented by foresight—Success depends on fitting means—Cunard line shows what can be done.

Dangers of Atlantic navigation.

A VOYAGE across the Atlantic must ever be attended with greater peril than almost any other ocean service of similar length and duration; arising, as this does, from the boisterous character and uncertainty of the weather, from the icebergs which float in huge masses during spring along the northern line of passage, from the dense fogs frequently prevailing, and from the many vessels of every kind to be met with, either as employed in the Newfoundland fisheries, or in the vast and daily increasing intercourse between Europe and America.

In such a navigation the utmost care and caution requires to be constantly exercised, especially by steamships. Nevertheless, though the Collins line

of steamers performed this passage with a speed hitherto unequalled, they encountered no accidents worthy of note during the first four years of their career; but terrible calamities befell them soon afterwards.

Collision of *Arctic* and *Vesta*, 1854.

On the 21st of September, 1854, the *Arctic*, according to her usual course, left Liverpool for New York. She had on board 233 passengers, of whom 150 were first class, together with a crew of 135 persons, and a valuable cargo. At mid-day on the 27th of that month, when about 60 miles south-east of Cape Race, and during a dense fog, she came in contact with the French steamer *Vesta*. By this collision the *Vesta* appeared at first to be so seriously injured that, in their terror and confusion, her passengers, amounting to 147, and a crew of fifty men, conceived she was about to sink, and that their only chance of safety lay in getting on board the *Arctic*. Impressed with this idea many of them rushed into the boats, of which, as too frequently happens, one sank immediately, and the other containing thirteen persons was swamped under the quarter of the ship, all on board of her perishing. When, however, the captain of the *Vesta* more carefully examined his injuries, he found that, though the bows of his vessel were partially stove in, the foremost bulkhead had not started. He, therefore, at once lightened his ship by the head, strengthened the partition by every means in his power, and by great exertions, courage, forethought, and seamanship, brought his shattered vessel without further loss into the harbour of St. John's.

Arctic founders

In the meantime a frightful catastrophe befell the *Arctic*, and one so little anticipated that the persons

on board of her, supposing that she had sustained only trifling injury by the collision, had launched a boat for the rescue of the passengers and crew of the *Vesta.* It was soon, however, discovered that their own ship had sustained fatal injuries, and that the sea was rushing in so fast through three holes which had been pierced in the hull below the water-line, that the engine fires would be soon extinguished. The *Arctic's* head was therefore immediately laid for Cape Race, the nearest point of land, but in four hours from the time of the collision, the water reached the furnaces and soon afterwards she foundered. As it was blowing a strong gale at the time, some of the boats into which her passengers and crew rushed were destroyed in launching, others which got clear of the sinking ship were never again heard of, and only two, with thirty-one of the crew and fourteen passengers, reached Newfoundland. Among those who perished were the wife of Mr. Collins and their son and daughter, but the captain, who remained on board to the last, and the first as well as the second and fourth officers were saved. Seventy-two men and four females sought refuge on a raft which the seamen, when they found the ship sinking, had hastily constructed, but one by one they were swept away—every wave as it washed over the raft claiming one or more victims as its prey; and at eight o'clock on the following morning, one human being alone was left out of the seventy-six persons who, only twelve or fifteen hours before had hoped to save their lives on this temporary structure. The solitary occupant of this fragile raft must have had a brave heart and a strong nerve to

have retained his place upon it for a day and a half, after all his companions had perished, for it was not until that time had elapsed that he was saved by a passing vessel: his tale of how he and they were parted was of the most heart-rending description.[1]

As a large proportion of the first-class passengers of the *Arctic*, consisted of persons of wealth and extensive commercial relations in the United States, as well as in England and her colonies, besides more than one member of her aristocracy, the loss of the *Arctic* and the terrible incidents in connection with her fate caused an unusual amount of grief and consternation on both sides of the Atlantic.

Loss of the *Pacific*, 1856.

Within little more than twelve months from this time, another great calamity befell the Collins Company, and the sad loss of their steamer *Pacific*, from the mystery in which it is shrouded, if not as lamentable as that of the *Arctic* (for the soul of man has never been harrowed by its details), was equally deplorable. Though the ocean, as in this instance, leaves no record of its ravages, the stern fact, announced in the brief words *she was never heard of*, tells itself the sad, sad tale, that a great ship, with all her living inmates, in infancy, in manhood and in old age, it may be full of hope and joy, has been engulfed in the deep blue waters of the Atlantic—summoned, perhaps in a moment, to an eternity more mysterious than that which still surrounds their melancholy fate.

This splendid but unfortunate ship left Liverpool on the 23rd of January, 1856, having on board

[1] See Annual Register, 1854, page 162.

25 first-class passengers, 20 second-class passengers, and a crew of 141 persons, almost all of whom were Americans. She carried the mails and a valuable cargo; the insurances effected on her amounting to $2,000,000. But no living soul ever appeared to tell when and where or how she was lost, nor were any articles belonging to her ever found to afford a clue to her melancholy fate; it can only be supposed that she sprang an overwhelming leak, or more probably struck suddenly, when at full speed, on an iceberg and instantly foundered.[1]

Renewed exertions of the Collins, and, also,

These terrible disasters did not, however, quench the spirit of the American people, however much they may have grieved over them. They were still as resolved as ever to maintain an Atlantic mail service of their own, and the requisite capital was soon found to supply the place of the two vessels which had been lost; one of the new steamers, the *Adriatic*, surpassing in size, speed, and splendour any of her predecessors. Nor did these disasters check the passenger traffic which, in eight years from the time of starting the Collins line, had increased five-fold. This, however, is in a great measure accounted for by the fact that, in the meantime, another line of steamers, specially adapted for the emigrant trade, to which reference will hereafter be made, had, during that period, been started, thus affording far greater facilities for an economical and comparatively

[1] One reason why such ships as the *President* and *Pacific* have left no trace of their fate is, that they have foundered almost instantaneously in deep water; the result of this would be that all the wood in them, including their boats, would be carried down with them, the wood being at the same time made so heavy by the water forced into its pores, that it could never again float to the surface.

easy intercourse between the two countries, than the sailing packets had hitherto provided.

[o]f the [C]unard [C]ompany. The Cunard Company having now other steam companies to contend against besides the Collins line, made renewed and extraordinary exertions to maintain their position. In 1852, they sent forth the *Arabia*, of 2400 tons, and of 938 horse-power, built on the Clyde and supplied with engines by Robert Napier; and, in 1855, the first iron ship of their fleet, the *Persia*, was dispatched to compete with the *Adriatic*.

Launch of the *Persia*. The *Persia*[1] was a great step in advance of any other ship built for the Cunard Company up to that period, and though they had added twenty-six vessels to their fleet since they launched the *Britannia*, she was not merely the first they had constructed of iron, but the first ocean-going steamer in any way approaching her dimensions, launched from the yard of Robert Napier and Sons, who had now added to their business of engineers that of iron-ship builders.

Curious to relate, among the vast concourse of people who witnessed the launch of this ship, there were persons who had been also present at the launch of the *Comet* on the Clyde, and who were thus living witnesses of the extraordinary progress of steam navigation during the course of their own experience. The *Persia*, besides being the largest[1] vessel hitherto owned by the Cunard Company, surpassed in speed all their other vessels.[2]

[1] The *Persia* is 3766 tons gross register, being 350 feet length of keel for tonnage, 45 breadth of beam, and 30 feet depth of hold, with a mean draught of water of 20 feet. She has side-lever engines of 917 nominal horse-power, working up at sea to 3600 indicated horse-power.

[2] Shortly after the *Persia* was dispatched, Mr. Vanderbilt of New

With such vessels as the *Asia*, *Africa*, *Arabia*, and *Persia* on their line, the Cunard Company bade defiance to competition. In a comparative statement of the voyages of the principal steamers then engaged in the Transatlantic trade, including the Collins line, the average speed of the Cunarders throughout the year 1856 exceeded that of all others;[1] the *Persia* during that year having, on four occasions, made the passage from New York to Liverpool in less than nine days and a half, indeed, in one instance, in nine days, four hours, and thirty-five minutes.

But the Collins Company continued to run their ships with regularity and undaunted vigour up till 1858, and it was only when the shareholders discovered that they were competing with the Cunard

Collins line relinquished, 1858.

York launched a ship which he named after himself calculated to surpass in speed any steamer then afloat, but, on the authority of the *Philadelphia Ledger*, she was defeated by the *Persia* by thirteen hours on a passage of 3068 nautical miles across the Atlantic, the average speed returned on this occasion being: *Vanderbilt*, 13·86 nautical, or 15·98 statute miles per hour; and that of the *Persia*, 13·95 nautical, or 16·08 statute miles per hour. Through the courtesy of the owners of the latter ship I am enabled to furnish (Appendix No. 9, pp. 603–5) an abstract of her voyages from the 1st of January, 1856, to the 31st of December, 1867, condensed.

[1] *Comparative Statement of Average Sailings of various Transatlantic Steamers during the Year* 1856.

	Liverpool to New York.	New York to Liverpool.
Cunard (Boston)	13·07 days	11·12 days
do. (New York)	12·67 „	11·03 „
Collins	12·16 „	12·03 „
Bremen	15·00 „	14·12 „
Old Havre	14·18 „	13·16 „
Havre (Vanderbilt)	13·00 „	13·00 „
do. (French)	17·00 „	15·00 „
Glasgow	15·12 „	13·08 „
Hamburg	15·12 „	16·00 „

and other British steamers at a ruinous loss, and declined to provide more capital, that this great but spirited undertaking was relinquished. Though the most strenuous exertions were made, every effort failed to resuscitate the Company. The losses had been stupendous: minor and separate interests, moreover, as well as those persons who, from the first, had been opposed to subsidies for the conveyance of the mails, now brought their influence to bear upon Congress. The merchants and shipowners of Boston, Philadelphia, Baltimore, and other places, envious of New York, complained loudly of that city having a virtual monopoly of the Transatlantic trade, nor did the owners of the sailing packets fail to renew their protests against the large annual grants of public money voted for ocean steam communication. In the face of these remonstrances, and of the numerous hostile interests now at work, the American Government declined to grant any further subsidies to the Collins Company, or to aid, from the public purse, another undertaking which proposed to take its place.

Scotia.

But the Cunarders did not relax their efforts to maintain the high position they had now attained. In 1862 they sent forth the *Scotia*, of which an illustration will be found on the following page.

Her great strength.

She also was built of iron, but superior in speed and strength to the *Persia*, and of somewhat greater power and dimensions.[1]

[1] The dimensions of the *Scotia* are, length of keel and forerake, 367 feet (nearly twice the length of the *Britannia*); breadth of beam moulded, 47½ feet; depth for tonnage, 30½ feet; gross register 3871 tons. Her engines are 975 nominal horse-power, but she works at sea up to 4200 horse-power. The diameters of her two cylinders are respectively 100 and 144 inches. Her paddle-wheels are upwards of 40

CUNARD STEAM-SHIP "SCOTIA."

"In framing the *Scotia*, the utmost attention was bestowed for the purpose of giving strength and firmness to the whole of her large hull so as to enable her to resist strain, and make her invulnerable to concussion. To secure strength she is bound in the strongest manner throughout from stem to stern, and she is fitted with six transverse bulkheads which, in the length of the ship, divide the hull into seven perfectly water-tight compartments, and besides these she has also four water-tight subsidiary or caisson compartments. She is traversed from stem to stern by five keelsons, all of which are firmly secured at each bulkhead. At the bow, her framing is diagonal to afford the greatest possible resistance in case of concussion, and from the various peculiarities of her construction and the excellence of the material with which she has been built, the *Scotia* is admitted to be the strongest as she is certainly (1865) the finest merchant-steamer afloat, and, as such, may be safely adopted as the champion and model of a mercantile ocean steam-ship."[1]

and speed.

This magnificent specimen of a merchant-steamer surpassed in all respects any vessel which had hitherto crossed the Atlantic, having made the passage (allowing for difference in time, but including the detention of landing mails and passengers at Queenstown) in eight days, twenty-two hours, from New York to Liverpool.

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feet in diameter, and her bunkers contain 1800 tons of coal. The weight of iron in her hull alone is 2800 tons. On her trial trip she attained a speed of 19 statute miles an hour. Her cost ready for sea was 170,000*l.*, but labour, iron, and other materials have risen considerably in price since she was contracted for in 1860.

[1] "The Steam Fleet of Liverpool," p. 17.

Though the Collins Company had collapsed, the Cunard Company were not left in undisputed possession of the intercourse they had established, except so far as regards any further competition from steam-vessels subsidised by the Governments of Great Britain or of the United States. But as no mean rivals in the trade had arisen from among their own countrymen, they found it necessary to add vessel after vessel to their fleet, each new one of a still more improved description, and therefore wisely turned their attention to the screw as a means of propulsion.

Russia, first Cunard screw-steamer, 1862.

In 1862 they sent forth the *China*, in 1864 the *Cuba*, in 1865 the *Java*, and in 1867 the *Russia*, all built of iron in the Clyde, but fitted with the screw instead of paddle-wheels, and embodying various improvements upon even the *Scotia*. The *Russia* is 2960 gross register, and, though her engines are only 492 horse-power,[1] her speed equalled that of either the *Persia* or *Scotia*, she having made the passage from New York to Queenstown in eight days and twenty-eight minutes, and from Queenstown to New York in eight days, five hours, and fifty-two minutes mean time, thus affording another instance (if, indeed, any more were required) of the superiority of the screw over the paddle-wheels.

But as the trade increased the Cunard Company found it necessary to direct their attention to the adoption of every improvement, however minute, which their experience, combined with the knowledge and science of the age suggested, so as to increase considerably the capacity of their vessels,

[1] This is her nominal power, but as her cylinder is 87 inches diameter, and stroke 48, the power indicated is from 2700 to 3000 horses.

without lessening their speed. Since they launched the *Russia* they have added to their fleet five vessels, the *Calabria*, *Algeria*, and *Abyssinia*, each of 3300 tons, and the *Bothnia* and *Scythia*, each of 4535 tons, all built of iron and fitted with the screw. The *Bothnia* and *Scythia*, (built by Messrs. James and George Thomson, of Glasgow,) are in all respects similar. They are each 455 feet in length over all, with a breadth of 42½ feet, and a depth of 36 feet. In each, accommodation has been afforded for 300 first-class and 800 third-class passengers. They are barque-rigged, and have four decks—the upper or promenade deck, the spar deck, the main deck, and the lower or orlop deck; their engines are on the compound principle.[1] Their engines are 507 nominal horse-power, of the massive description common to the Cunard liners, so essential for safety on an Atlantic voyage. They have each two jacketed cylinders, the small cylinder being 60 inches and the large one 104 inches, with eight tubular boilers and twenty-four furnaces.

Bothnia and *Scythia*, 1874.

Their construction.

The coal bunkers of the *Bothnia* are capable of holding 1200 tons of coals. Steam winches of extra size are attached to all the hatches, and the weighing of the anchor is secured by the use of

[1] The compound engine has two cylinders, one frequently double the diameter of the other. Steam at a high pressure is admitted from the boiler into the smaller cylinder, and, after it has driven the piston *up* or *down*, it is allowed to pass into the larger cylinder when, by its expansive property, it assists in driving the larger piston *down* or up When it has exerted its full expansive effect, it is then in a condition to be condensed; and thus a compound engine combines the advantages of both a high pressure and low pressure or condensing engines. Compound engines are sometimes called "high and low pressure" engines, and there are a great many modifications of them, their principle however, being always the same.

"BOTHNIA."

Harfield's[1] steam windlass. Her *steam* steering gear is amidships, besides which she has powerful screw gearing, and, in further supplement of the guiding resources of the vessel, she can be directed, from a wheel-house aft, in the event of the steam gearing getting out of order while at sea.

[1] In the course of this work I have frequently had occasion to refer to the skill and genius displayed by the Americans in their adaptation of appliances to reduce or dispense with manual labour, but perhaps none of their inventions with this object in view can be compared with the windlass of Messrs. Harfield and Company (formerly Brown, Harfield, and Company), of London, who, beyond other inventions, have produced in their patent windlass, of which the following is an illustration—

a machine of strength, simplicity, and power, applicable to vessels of all descriptions, which has never been surpassed. This very compact instrument can be worked either by manual labour or by steam, and of its value in the latter case Mr. Harfield remarks: "The two principal points of advantage are (1) that the cable is led from the hawsepipe to the *underside* of the chain-wheel, then over and half round the side standard (formed like a riding-bit) away to the after stopper, thus forming the strongest means for riding securely; (2ndly), the chain-wheels are not attached rigidly to the windlass, but have a very simple *frictional* connection which can be set up to any desired extent so as to yield to a heavier strain."

The *Bothnia* (as well as the *Scythia*) is of unusual strength, being double plated for a considerable distance round the bilge, and having nine intercostal keelsons, while her spar deck, which is all of teak, is plated with iron. She carries twelve lifeboats, an unusual number for even a vessel of her large dimensions. Nor has the comfort and luxury as well as the safety of the passengers been neglected. In her main saloon, situated nearly amidships, 300 persons can conveniently dine at one time. There are besides separate drawing-rooms for ladies, and smoking and lounging-rooms for gentlemen. Outfit

Beyond the advance which has been made in the strength, speed, and capacity of these ships, since iron has been employed in their construction and the screw adopted as a propelling power, the improved accommodation afforded to passengers of all classes has been equally surprising. The state rooms of the *Bothnia* are indeed splendid, affording every comfort possible at sea, the sleeping-berths, in space, light, ventilation, and convenience, more resembling the rooms of an hotel than the cabins of a ship. (See illustration, p. 236.) By arrangements, which I have not space to describe in detail, the scuttles, or rather windows, of the upper tier of berths are no longer exposed to the wash of the sea, so that they can be kept open if desired, without in any way jeopardizing the safety of the ship in the most stormy weather; nay, even when closed, the ventilation remains perfect, and is continued to the other range of cabins below. Thus a passage across the stormy Atlantic is no longer one of enduring discomfort or suffering, as it was in the days of our fathers, and cabin accommodation.

SECTION AND DECK OF CABINS OF THE CUNARD STEAM-SHIPS "BOTHNIA" AND "SCYTHIA."

but, to those who are not subject to sea-sickness, has now become a voyage of pleasure; and, though many of my readers may not be disposed to agree with me in this respect, the improvements in accommodation are so great that I should prefer spending the proverbial "month's holiday," which everybody now-a-days seems to require, on board of a modern steamship to spending it in most of our European hotels.

The *Scythia* was launched in October 1874, and the *Saragossa* and *Cherbourg*, now in course of construction on the Clyde by Messrs. Thomson for the Cunard Company, are not likely to be in any way inferior.

This company now own forty-nine steam-vessels of 90,208 tons, and 14,537 horse-power;[1] and, in a foot note, will be found an interesting table of the comparative consumption of coal in fourteen of these steamers employed in different trades.[2] Vessels owned by Cunard Company.

[1] See Appendix No. 10, pp. 606–608.

[2] *Comparative Statement of Consumption of Coal in various Cunard Steamers.*

Names of Ships.	Indicated Horse-power.	Consumption of Coal per Day.	Consumption of Coal per Indicated Horse-power per Hour.	Consumption of Coal per Mile.
		Tons	lbs.	Cwts.
Asia	1,805	78	4·0	5·6
Arabia	3,005	116	3·6	7·5
Persia	4,026	150	3·47	9·0
Scotia	4,500	159	3·6	9·5
Russia	2,700	95	3·28	6·0
Parthia	1,950	42	2·0	3·3
Bothnia	2,543	64	2·34	4·1
Abyssinia	2,450	91	3·46	5·68
Marathon	1,450	35	2·25	2·5
Sidon	760	16	1·96	1·4
Trinidad	702	16	2·11	1·37
Nantes	687	15	2·03	1·38
Sidon	824	19	2·15	1·14
Nantes	620	13	1·95	1·32

But, a much more interesting and instructive table (embracing all the Cunard vessels that have been employed in the Transatlantic trade since 1840) is given in the Appendix,[1] and forms in itself a complete history of the advance of steam-vessels during the last thirty-five years. It is remarkable to note the extraordinary progress achieved since the *Britannia* made her first voyage in 1840. Though measuring 1,139 tons, she had a capacity for only 225 tons of cargo, whereas the *Bothnia*, of 4,335 tons, built in 1874, takes 3000 tons of cargo, or nearly fourteen times as much, though only four times larger. The *Britannia* carried ninety passengers, whereas the *Bothnia* carries 340, or close upon four times as many. The former steamed $8\frac{1}{4}$ knots an hour, whereas the latter steams 13, or more than half as quick again, and the *Bothnia* does all this extra work on less than half the quantity of fuel per indicated horse-power per hour, and on about the same quantity for the actual number of miles run.

Comparison of *Britannia* and *Bothnia*.

As it thus appears that engines of 507 nominal horse-power now drive a vessel of 4,335 tons, at a speed nearly twice as great as engines of 425 nominal horse-power drove a vessel of only 1039 tons in 1840, with not half the consumption of coals, may we not hope from the progress of science and

[1] See Appendix No. 11, p. 608. For this most valuable and instructive table I am altogether indebted to Mr. Burns, who considers toil a pleasure if he can only furnish information which may prove useful to the public. Indeed, had it not been for him and other gentlemen largely engaged in maritime commerce, who have so readily rendered me their aid (for which I tender my warmest thanks), I should not have ventured to offer to the public so large an amount of purely original matter as this volume contains.

o 1875.

OF ENGIN

ers and Furnace

Number of Furnaces.	Fire- A fe
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16	2
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20	4
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24	6
40	8
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24	4
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28	5
24	4
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,,	4
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INIA."

Diffe

3·75 times m

3·70 times m

1·46 times fa

Decrease of 2

increased knowledge for still more extraordinary results at the expiration of another thirty-five years?

The Cunard Company have now afloat, and engaged in their Transatlantic service alone, no less than twenty-three magnificent steam-ships and two steam-tenders of a gross registered tonnage of 64,718 tons, and 10,000 horse-power.[1] And here I must state that, though they have for thirty-five years been traversing that stormy ocean, now almost daily, with surprising regularity and during the most tempestuous weather, they have only lost two vessels; *but it is still more remarkable,—indeed, it is an extraordinary fact,—that neither life nor letter entrusted to their care has been lost through shipwreck, collision, fire, or any of the too frequent causes of disaster, during the numerous voyages made by the Cunard steamers across the Atlantic.*

Cunard Company never lost a life or a letter during thirty-five years.

How is this? Here is a problem well worthy of solution, and one too of great national importance. When we consider the terrible loss of life and property at sea, as revealed by the returns of casualties annually published by the Board of Trade, and observe the mass of legislation to prevent or lessen,

Reasons.

[1] See Appendix No. 10, page 508*.

Note.—The Cunard Company, consisting, as I have explained, of only a few private individuals who started business just half a century ago, now own a fleet of steam-ships whose tonnage is greater by far than the whole mercantile steam shipping of the German Empire, and nearly half as great as that of France, Holland (once our greatest rival), and Hamburg put together. Since they commenced they have had no less than 164 steam-ships under their flag. They employ 6000 men, shipping and discharging in the course of one year, 42,000 seamen.

See evidence of Mr. John Burns before the Royal Commission on Unseaworthy Ships, 1874.

In 1871, France owned (including the vessels of the Messageries Maritimes) 160,478 tons; Holland, 36,644 tons; and Hamburg, 45,669 tons of steam shipping.

but in vain, these ever increasing, and too frequently most lamentable casualties, we cannot but feel that a noble work has yet to be achieved. What a boon would be conferred on mankind if this great problem could be satisfactorily solved! I cannot hope to do so, but I shall endeavour to show that, in the success of the operations of the Cunard Company, in the regularity of the voyages of their ships, and in the safety of life and property entrusted to their care, there exists a wise power of control which might be advantageously applied to vessels in other trades.

Now, regularity in itself, though perhaps more applicable to transit on land than sea, is a means of safety, while irregularity or rather want of punctuality has been the cause of an untold number of accidents involving destruction of property beyond estimation, with a sacrifice of life which no mathematician would attempt to value. Indeed it may safely be affirmed that the number of persons who have lost their lives through irregularity alone while travelling by land and sea during the present century, would exceed that of the occupants of a town of considerable size.

Value of punctuality.

With the Cunard Company punctuality is a matter of the highest consideration, for their ships sail as is the rule with the Transatlantic lines in all weathers, not merely to the day but to the hour and even to the minute of the time advertised. On board every man has his allotted station and his special duty to perform. Nor is this all, every commander and officer must show that he is thoroughly competent, in all respects, for his duties, while attention to these duties is rigidly enforced.

From my own experience I can state (for I have on two occasions crossed the Atlantic as a passenger in their steamers) that I found prevailing on board a very superior state of things to what I have noticed in too many steam-vessels in other trades. The captain was seldom to be seen, except at his duty, nor was he ever to be found mingling or gossiping with the passengers when any duty, however trivial, required his attention, even though the regulations laid down by the owners for his guidance might have allowed him to do so. No officer was ever seen speaking to the passengers except perhaps to answer a question. If you entered the engine-room, the engineers in charge were invariably at their stations ready to stop the machinery at a moment's notice, while all the assistants, down to the furnace-men and coal-trimmers, were at their respective posts attending to their individual duties. Going aft, you would find the men at the helm with an officer by their side to make sure that the steering course was adhered to, and, whether you walked to the bridge or the forecastle, you would find men on the "look out," alike in fine weather and in foul, with their attention steadily directed to the ship's course, and with the means of instant communication with the officer of the watch, and, through him, with the engineer in case of danger. In approaching land, when in soundings, seamen in both chains were to be found casting or prepared to cast the lead, or with the deep sea line on the weather bulwark ready to be run out according to circumstances or the anticipated depth of water.[1]

Admirable discipline in their ships.

[1] The chief-mate of the steam-ship *Schiller*, a German steamer engaged in the Transatlantic trade, which was lost, with 333 persons on board,

If you looked around you would find everything in its place ready for instant action; if you glanced at the boats you would find their tackles in order and the boats themselves clear and free from all encumbrances with the plugs, oars, and rudder ready for immediate use; if you looked below you would observe the night-lamps carefully guarded from accident, and the hose stretched out and attached to the engine so that water could be instantly applied to quench any fire that might accidentally arise in any part of the ship. Everywhere the most perfect order and quietness prevailed.

Regulations of the Company.

That my readers may understand more thoroughly the nature and value of these regulations, I furnish[1]

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on rocks contiguous to Scilly, in thick weather during the night of the 7th of May, 1875, states in his evidence: "The *Schiller* was out of her reckoning: they *thought* they were 25 miles from the land. They had had fog for three days, had been unable to take observations, and HAD NOT ONCE CAST THE LEAD." (See report of official inquiry ordered by the Board of Trade, *Times*, 2nd June, 1875.) If any of my readers will look at the soundings marked on a Channel chart they will see that this steamer would most probably not have been lost had only one cast of the lead been taken during the three days of fog.

[1] The instructions to the captains are in print and of considerable length, but the leading points in regard to the discipline and safety of the ship and all persons on board are as follows:

"We rely on your keeping every person attached to the ship, both officers and people throughout the several departments, up to the high standard of discipline and efficiency which we expect in the service. Your own practical knowledge may be your best guide, but we will allude to the following things:—

"The charge of the ship, in all its departments, is put under the command of the captain.

"The departments on board are classed under three heads:

"Sailing, engineers, stewards and servants.

"The captain to divide the sailors and officers into two watches only, so that two officers may be always on deck."

"Keep good look-outs.—The trust of so many lives under the captain's charge is a great responsibility; requiring vigilance night and day.

for their information the more important heads of the instructions given to all the commanders of the Cunard ships. They are clear and to the point

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"Be most careful as regards fire and the use of naked lights—See the rules in cabin regulations on this point attended to.

"Good steering is of great value.—Pick out the best helmsmen for this duty.

"We beg your especial care to the drawing-off of spirits. The spirit-room should, if possible, be entered during the day *only*. See instructions to the purser under this head, and enforce them.

"Avoid familiarity with any particular set or portion of your passengers; avoid national observations and discourage them in others; keep yourself always a disinterested party ready to reconcile differences; be civil and kind to all your passengers—*recollect they will value your services on deck looking after their safety more than talking with them in the saloons.*

"The engine store-room (the place where the waste and oil are kept) should have the engineers' close attention, so as to prevent fire, or even the alarm of it, not only on the passage but in port.

"It is to be borne in mind that every part of the coast-board of England and Ireland can be read off by the lead; and, on making land, you should never omit to verify your position by soundings; rather lose time in heaving the ship to, than run the risk of losing the vessel and all the lives on board.

"You are to understand that you have a peremptory order, that, in fog or snow-storm, or in such state of the weather as appears attendant with risk in sailing, you are on no account whatever to move the vessel under your command out of port or wherever she may be lying in safety, if there exists in your mind a doubt as to the propriety of proceeding; and, at the same time, you are particularly warned against being influenced by the actions of other captains who may venture to sail their vessels in such weather.

"In any case when, in sailing, you are overtaken by thick weather, fog, or snow-storm, the most extreme caution is to be exercised, and you are not to be actuated by any desire to complete your voyage, your sole consideration being the safety of your ship and those under your charge; and we caution and instruct you in such circumstances to make CONSTANT USE OF THE LEAD, and to enter in your log the fact of your having done so.

"In the navigating of our vessels generally, we have entire confidence in the ability of our captains, and full reliance upon their judgment and discretion, knowing, by experience, the fitness of each man for the responsibility of his post; but in the matter of fog, the best of officers become infatuated, and often attempt to push through,

and, though every person on board is subordinate to the commander, the engineer also receives printed instructions for his guidance. Distinct regulations are laid down for exercising the boats and fire-pumps, and for their prompt and efficient use in case of accident:[1] even the duties of the stewards and servants are as clearly defined, so that in the cabin the same quiet and order prevails as in all other parts of the ship.

Neglect of these or similar orders has too often led to the most serious consequences; hence, in all the ships of the Cunard Company, as on the Transatlantic ships, generally, they are enforced even to the most minute detail. Any negligence with regard to them would be severely reprimanded, and any second offence or any wilful neglect, would be punished by disrating or dismissal from the service. Every person on board from the captain to the cook's mate knows this: consequently, these regulations do not hang neglected on the walls as regulations of the same kind too frequently do in too many other vessels, they are carefully studied, as every man on board knows full well that they must be attended to. Nor does the care of the Company for the safety of their ships and the lives of their passengers end here. To avoid as

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when common sense and prudence would teach them to exercise patience.

"You will bear in mind that we are now impressing upon you stringent rules, long laid down by us for the guidance of our captains, the terms of which are plain and unmistakeable, and can leave no doubt as to your clear course of action in the circumstances referred to, and we expect them to be implicitly obeyed; but, if otherwise, the conduct of those who disregard them can only be looked upon as extremely culpable, and deserving the severest censure."

[1] Appendix No. 12, pp. 609–10.

far as possible collision at sea they have within the last two or three years issued a notice, which is advertised almost daily in the leading public journals, of the course their ships will pursue in their passages across the Atlantic.[1]

Though the "dangers of the sea" are proverbial, they might be reduced by at least two-thirds of their present amount. This is neither an exaggerated nor a haphazard statement, for upon a close examination of the wreck returns, it will be found that a still larger proportion could be prevented. A large volume might be indeed written to advantage on this important subject. But as our space is limited, and, having already (vol. iii. chap. xvii.) directed the attention of my readers to it, I shall only now ask them to turn over in their minds the too frequent accounts of shipwrecks which appear in the public journals, and such expressions as "drunkenness," "overloading," "negligence," "incompetency," "fire," "collision," and "unseaworthy ships and sailors,"

[1] "Cunard line.—Notice.—With the view of diminishing the chances of collision, the steamers of this line will henceforth take a specified course for all seasons of the year.

"On the outward passage from Queenstown to New York or Boston crossing meridian of 50 at 43 lat., or nothing to the north of 43.

"On the homeward passage, crossing the meridian of 50 at 42 lat., or nothing to the north of 42."

Note.—In July, 1871, the late Mr. William Wheelwright laid before Mr. Chichester Fortescue (now Lord Carlingford), then President of the Board of Trade, a large and beautifully executed chart, "showing an eastern and western route for steamers crossing the Atlantic, whereby collision may be avoided, and the fleet of fishing-vessels on the banks of Newfoundland protected." Mr. Wheelwright appears to have been the first person to make known this valuable suggestion (which might with advantage be enforced on all passenger steamers engaged in the northern branch of the Transatlantic trade), as he published a pamphlet on the subject so far back as 1846.

Most disasters may be prevented by foresight, &c.

will recur to their recollection as the alleged causes of too many of these disasters. This is no overdrawn picture, *it is but too true.*[1]

With these facts in view, and having before them the regulations of the Cunard Company with the knowledge, also, of the *perfect* safety with which their ships have traversed, at the highest rate of speed for a long series of years, one of the most stormy oceans; one, too, where icebergs abound, and where far more ships navigate than anywhere else, they may ask themselves with advantage this question and study it in their own minds: *Cannot this melancholy list of maritime casualties be materially reduced?* IT CAN and *must.* Opinions may differ widely as to the most effective mode of carrying into practice the means at our disposal for bringing about a more satisfactory state of things than exists at present. But the work has to be done, and ought to be done, when the great fact, which cannot be too often repeated, is considered that the Cunard Company's steamers have for thirty-five years constantly traversed the Atlantic without the loss of the life

[1] If my readers will refer to the Report of the Royal Commission on Unseaworthy Ships (1873–74), they will find the following summary of the losses of ships at sea from 1856 to 1872 inclusive, which have been the subject of enquiry at the instance of the Board of Trade:—Losses attributable to unseaworthiness of hull, compasses, equipment, and outfit, within the power of the owners to remedy, 4½ per cent.; losses to be attributed to carelessness, drunkenness, ignorance, incompetency, and absence of discipline, 65 per cent.; losses from stress of weather, and causes not apparently preventable, 30½ per cent. This last item includes 38 wrecks of which no cause is assignable. See also article, "Merchant Shipping Legislation," in the 'Westminster Review' for April, 1875, by Mr. Charles Lamport; and a very able article by his brother, the late Mr. W. J. Lamport, of Liverpool, entitled the "Plimsoll Agitation," which appeared in the 'Theological Review' for January, 1874.

of a passenger, or of a letter entrusted to their care.

Some persons may say that this arises from extraordinary "good luck." As a rule, I have no faith in such old sayings; good or bad luck are expressions only applicable to games of chance where no skill, genius, industry, or prudence are required, and where every man has an equal opportunity of winning a prize. In all other matters success depends on the means applied to obtain it. And there can be no doubt that the freedom from accident on board of the ships of the Cunard Company may be attributed, almost entirely, to the wise measures adopted to prevent casualties, and to the rigour with which they are enforced. If this conclusion is sound and borne out by the facts, why should we not make the rules of that company or similar rules adopted by other steam lines, the bases of our maritime legislation, especially in passenger ships, and enforce them by legislative enactments? We could thus dispense with a large portion of the confused mass of maritime legislation now in force, and from its extent, in too many cases, practically worthless.[1]

Success depends on fitting means.

With regard to the seaworthiness, of a ship and the competency of her crew, it would, while maintaining the valuable existing laws for the examination of

[1] It is satisfactory to note by the official returns, that, with respect to ships *carrying passengers*, the loss of life is not so great as is generally supposed. Between 1847 and 1873 inclusive, 22,186 vessels left the United Kingdom, with 5,388,163 passengers and 847,550 of crew—in all 6,235,713 persons. Out of the above number, 103 ships were lost, and 6129 lives, giving a percentage in the loss of ships of ·46, or not one-half per cent., and in the loss of life ·09, or less than one person in the thousand thus conveyed. This return refers to ships which come under the "Passenger Act." See "Report of Royal Commission of 1873-74."

the officers, and the engagement and discharge of the seamen, be desirable to sweep away the great bulk of the legislative technical *details*, which even Parliament in its wisdom knows little about, and require shipowners to produce vessels in all respects seaworthy, under heavy penalties for negligence, while leaving them to manage their own affairs as to the best mode of construction, number, and efficiency of crew, outfits, load line, and so forth. Such matters cannot be effectually dealt with by Act of Parliament; but, if they could, is it just, is it proper, that the nation should be required to take upon itself responsibilities, essentially, belonging to individuals? If it does, we shall most assuredly create greater dangers and bring about greater misfortunes and calamities, than those we attempt to obviate by well-meant but injudicious legislation.

Cunard line shows what can be done.

The case of the Cunard Company is a striking instance of what individuals can do. Legislative enactments are not required to regulate the conduct of such men as constitute the managing owners of this company, nor of that of the great majority of British shipowners. They know that a good ship, well managed and well found, is a much better investment than a bad one. But they likewise know, and therefore the Government can always depend upon the support of such men in any wise and necessary legislative measure, that there are interlopers in their trade who "go down to the sea in ships and do business on the mighty waters" of quite as knavish a character and, even more heartless, than the swindlers who concoct joint stock undertakings on shore to rob the widow of her mite and

the fatherless children of their daily bread: they know, also, that there are very bad men who send their ships to sea to be lost, and villains who actually scuttle them. Nor are they unaware that, among their number, there are men who smile when their ships are lost *because* they are well insured.[1] Therefore, so far from objecting to general laws of even a much more stringent character than those at present in force, they would welcome them if, by their rigorous enforcement, the perpetration of crime could be more effectually checked. If, for instance, punishment was made more certain and severe, bad men would hesitate before they over-insured their ships in the hope of realising profits out of disasters, especially where loss of life occurs. It is only a question of degree between the man who smiles when his ship founders, and the rogue who dis-

[1] There are probably very few shipowners who actually over-insure ship or freight with a view to their loss, but when these are fully covered, so that a loss may become a gain, it is not in human nature to be, under such circumstances, as careful as if a loss were *really* a loss; and, when times are bad or ships unprofitable, the temptation to carelessness is very great.

Not long since a shipowner of high reputation and on whose word I can implicitly rely, met another shipowner, who, complaining of the bad times, in the course of conversation said: "And to make matters worse I have also had a bit of very bad luck." "What was it?" enquired my friend. "Oh!" said he, "a ship of mine I had just sold was lost the first voyage after I parted with her." "Well," replied my friend, "and where was the bad luck there?" "*Where?*" exclaimed this "unfortunate" shipowner, "why I bought her twenty years ago, and insured her at her full value, and had kept her so insured till I parted with her." "And what made you do that?" enquired my friend. "Oh!" replied he, "she was an old ship, and an old-fashioned ship, and I thought that if she *did* happen to go to the bottom I might as well have a good and a new one in her place."

In relating this incident, my friend added that he was not less taken aback by the *naïveté* and apparent innocence with which these remarks were made, than by the story itself.

patches her for the purpose of being cast away; and Parliament, when it again deals with the loss of life and property at sea, might do well to direct its attention more than has hitherto been done to *over-insurance*, and to the insurance laws of our own and other countries. To limit the amount insured to the honest value of the article thus protected from loss, may appear a simple enough matter, but the whole subject is surrounded with difficulties. It must not, therefore, be hastily dealt with, and before any legislation is attempted, should be fully investigated, either by a committee of the House of Commons or by a Royal Commission.

CHAPTER VI.

Liverpool, New York, and Philadelphia Steamship Company—*City of Glasgow*, 1850—*City of Manchester*, 1851—Speed of *City of Paris* and *City of Brussels*—Exertions of Mr. Inman to improve and facilitate cheap emigration to the United States—Large number of emigrants carried in the Inman steamers—*City of Chester*, 1873—*City of Berlin*, 1875—Ocean steamers to Canada, 1853—First mail contract, 1852—Allan line of steamers, 1856—Extent and capacity of its fleet—Speed of these vessels—Galway line a failure—Loss of *Connaught*, 1860—Rapid passage of *Adriatic*, 1861—Struggles between sailing-clippers and iron screw-ships—National Steam Navigation Company, 1863—Their splendid ships—Old Black Ball line—The Guion line, 1863—Mississippi and Dominion Company—White Star line, 1870—Strict regulations for safety—*Britannic* and *Germanic*—Their great speed—Details of *Britannic* and form of her screw—Difficulty of estimating real cost of steamers—Pennsylvania Company, 1873—Anchor line from the Clyde, 1856—Prodigious range of their trade operations—The *Victoria*—Hamburg American Steam Packet Company—North German Lloyd's.

Liverpool, New York, and Philadelphia Steamship Company.

THE year 1850 proved somewhat remarkable in the history of steam navigation. But among the various undertakings commenced in the course of that year, the Liverpool, New York, and Philadelphia Steamship Company, better known as the Inman line, was perhaps the most important.

Mr. William Inman, the managing owner, by whose energy their present large fleet of iron screw-steamers was created, had for some time given his attention to the application of the screw, for the purpose of propelling ocean-going steamers. Im-

pressed with its superiority over the paddle-wheel, he entered into communication with the late David Tod, of the firm of Tod and Macgregor, iron ship-builders and engineers in Glasgow, who had formed, in common with the owners of the *Great Britain*, the idea of starting a continuous service of voyages across the Atlantic with vessels built of iron and driven by screws, an experiment at that time considered rather hazardous, and, with that object, had in 1850 launched the *City of Glasgow*, a vessel of 1600 tons, and 350 horse-power. Subsequently, she was purchased by the Inman Company, and sailed from Liverpool for Philadelphia on the 17th of December, 1850, continuing in that service for many years.

City of Glasgow, 1850.

City of Manchester 1851.

In 1851, the Inman Company purchased the steamship *City of Manchester*, of which the following is an

"CITY OF MANCHESTER."

illustration, built also by Messrs. Tod and Macgregor,[1] and with these vessels a fortnightly service

[1] The dimensions of the *City of Manchester* are as follows:—Length on deck, 274 feet with 38 feet breadth of beam. She registers 2125 tons, and is propelled by engines of 400-horse power, driving a three-bladed screw. Her two foremasts are of tubular plate-iron.

between Liverpool and Philadelphia was established and continued up to the year 1857. Between 1851 and 1856 the *City of Baltimore*, the *Kangaroo*, and the *City of Washington*, all iron screw-ships, were added to this line.

In the year 1857 the Inman Company enlarged the area of their operations by making New York one of their ports of arrival, and establishing a regular fortnightly line thither. In 1860 they increased the service of their steamers to once a week; in 1863 to three times a fortnight, and in 1866 they sent forth their steamers twice every week during the summer months.

To some extent the failure of the Collins line proved the fortune of the Inman, for, when that unfortunate undertaking collapsed, Mr. Inman at once assumed their dates of sailing, and carried the United States' mails between England and America for some time afterwards with great regularity. Nor were the vessels of the Inman line less swift than their predecessors. Indeed, their *City of Paris*,[1] of 3081 tons gross register, and 500 nominal horse-power, and their *City of Brussels*, of 3747 tons, and 600 horse-power, far surpassed the fastest steamers of the Collins Company, and they in turn were surpassed by the *City of Richmond*.[2]

Speed of *City of Paris*, and *City of Brussels*.

[1] The *City of Paris* conveyed, in 1869, His Royal Highness Prince Arthur (now Duke of Connaught) to America in *six days twenty-one hours*, the quickest passage ever made to any port of the New World from Cork. The Prince attended Divine Service at Queenstown on Sunday, embarked at four P.M. that day, and was landed at Halifax, Nova Scotia, at half-past ten A.M. on the following Sunday in time for Morning Service at that place, which he also attended, much to his credit.

[2] The following is an extract from the logs of the *City of Brussels* and *City of Richmond*.

Exertions of Mr. Inman to improve and facilitate cheap emigration to the United States.

But whatever advantages may have been derived by carrying the United States' mails, Mr. Inman, apart from these, specially directed his attention to the conveyance of emigrant passengers (who found

"City of Brussels."

Sandy Hook to Queenstown. December, 1869.	Wind.	Courses.	Distance from Sandy Hook.	Latitude, N.	Longitude, W.	Remarks.
Saturday, 4	Southerly	East.	37	40·30	73·09	A.M.—9.15, passed Sandy Hook.
Sunday, 5	"	N. 85 E.	330	41·27	66·00	Moderate breeze and calm.
Monday, 6	Easterly	N. 69 E.	320	43·21	59·15	Moderate breeze.
Tuesday, 7	S. S. W.	N. 67 E.	336	45·32	52·00	Light breeze.
Wednesday, 8	"	N. 68 E.	346	47·44	44·14	Light breeze.
Thursday, 9	S. W.	N. 72 E.	371	49·42	38·18	Moderate breeze.
Friday, 10	West.	N. 85 E.	365	50·11	25·51	Moderate breeze.
Saturday, 11	N. W.	N. 80 E.	353	51·15	16·44	Fresh gale.
Sunday, 12	..	To Fastnet	266	..	..	A.M.—6.20, past Fastnet; 10.10, Queenstown.

"City of Richmond."

Queenstown to Sandy Hook. December, 1875.	Wind.	Courses.	Distances.	Latitude.	Longitude.	Remarks.
Saturday, 17	Calm.	S. 84 W.	290	50·58	15·41	P.M.—4.10, Received Mails. Calm and Cloudy.
Sunday, 18	Variable.	S. 80 W.	362	49·56	25·01	Light airs.
Monday, 19	Variable.	S. 72 W.	360	48·08	33·43	Light airs.
Tuesday, 20	S. E.	S. 68 W.	380	45·42	42·18	Moderate breeze.
Wedn'sday, 21	Variable.	Variable.	366	43·25	50·14	Light and Variable.
Thursday, 22	Calm.	S. 81 W.	363	42·00	58·11	Light airs and calm.
Friday, 23	Variable.		361	41·03	66·07	Light airs and fog, 9.25 A.M. Received Pilot. P.M. 10.00 stopped and sounded.
Saturday, 24	Variable.		361			P.M. 10.30 Sandy Hook.

in his ships greater comfort, and a much more rapid means of reaching the United States than could be obtained in the fastest of the American sailing packets), and thus laid, at the outset, the foundation for the future prosperity of the company he had formed. It was he who first gave to the masses from the overcrowded cities of Europe, more economical and rapid means than they had hitherto enjoyed of reaching a country where their labour was in demand, and, by wise and judicious arrangements in his steamers, supplied what had hitherto been to a great extent wanting, the more complete separation of the sexes on the voyage to the land of their adoption. While reaping the reward to which his meritorious services were justly entitled, he conferred a boon worthy of remembrance on myriads of poor people, and I should ill perform the duty I have undertaken, were I not to specially notice his exertions on behalf of those of the industrious working classes, who felt it necessary to seek for themselves and their children, the means of obtaining honest employment in other and in distant lands.[1]

[1] Mr. Inman was the first to start a regular line of steamers across the Atlantic consisting entirely of iron ships propelled by the screw; and as he and Mrs. Inman, greatly to their credit, made a voyage in one of their earliest emigrant steamers, expressly for the purpose of ameliorating the discomforts and evils hitherto but too common in emigrant ships, my readers may naturally desire to know something of Mr. Inman's history.

In a few words therefore I may state that he was born at Leicester in the year 1825, where his father (a partner of Pickford and Co.) then resided. Educated at the Collegiate Institution at that place, and at the Liverpool Royal Institution, he, in 1841, preferring business to a profession, entered a mercantile office; passed through various grades of clerkship under the late Mr. Nathan Cairns (brother to Lord Cairns), Messrs. Cater and Co., and Messrs. Richardson Brothers, (all merchants of Liverpool): of the latter firm he became a partner in January 1849, and had the entire management of their fleet of American

Large number of emigrants carried in the Inman steamers.

In 1856 and 1857, the Inman Company conveyed in their steamers eighty-five thousand passengers, to and from the United States of America, or about one-third of all the persons who crossed the Atlantic in steamships during these two years; and that this company long maintained the favourable prestige they had at first secured, may be seen by the official returns of emigrants landed in New York for the year 1870.[1]

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sailing packets then trading between Liverpool and Philadelphia. Here he first gained an intimate knowledge of the emigrant business which he has since pursued with so much success and public advantage.

Mr. Inman having watched with considerable interest the performances of the *City of Glasgow* on her first trip to America, was convinced of the advantages she possessed over, not merely their sailing-ships, but over paddle-steamers for the purposes of navigation, and therefore recommended her purchase to his partners. Acting on his advice, they bought and dispatched her with 400 steerage passengers in the winter of 1850 across the troubled waters of the Atlantic, very much to the dismay of that numerous body of men who had still no faith in the screw, and who dreaded the performances of any vessel thus propelled in so stormy an ocean, even though they had seen what the *Great Britain* had done years before. But the *City of Glasgow* did her work right well, and completely falsified the prophecies of the foreboders of disaster. The *City of Manchester*, which followed, "left a profit in the first year of her movements of 40 per cent." to her enterprising owners, and hence no more has been heard since that time of the inferiority of the screw to the paddle-wheel. One is often surprised to see a man so fully occupied, as he must have been, with his own affairs taking an active part in public matters; but we find Mr. Inman in his useful and busy career (like numerous other active men of business) a member of the Local Marine Board, a member of the Mersey Docks and Harbour Trust, a member of the first Liverpool School Board, a captain of the Cheshire Rifle Volunteers and the holder, too, of prizes, a magistrate for the county of Cheshire where he resides, the chairman of the Liverpool Steam Shipowners' Association of Liverpool, and an active politician, frequently called on to give evidence before Royal Commissions and Committees of the House of Commons. His life indeed affords an excellent example for the rising generation to follow.

[1] Passengers landed at New York from the United Kingdom in 1870 by the following steamers:—

In 1873 this Company added two magnificent screws to their fleet, the *City of Chester*, of which an illustration will be found on the following page, and the *City of Richmond*, each of 4700 gross, or 3000 net register tonnage, and 800-horse power. These vessels were built by Messrs. Caird and Co., of Greenock, and by Messrs. Tod and MacGregor, of Glasgow, and are each 453 feet 6 inches in length over all, with a beam of 43 feet, and a depth of hold of 36 feet. They are spar-decked, have iron masts and solid iron bulwarks, and they are ship-rigged. In midships, there are long rows of centre and side houses, for a portion of the passengers and crew, and where accommodation is likewise afforded for the steering gear which is wrought by manual labour or steam power. There are also "the galley-saloons," providing cooking apparatus sufficient for 1500 persons; while five of the side houses are devoted to the purpose of male and female hospitals. The engines of these vessels are compound with inverted cylinders and surface condensers; the large cylinder being 120 inches, and the smaller one 76 inches in diameter; the length of stroke of the piston is 5 feet; and their speed on trial was 16 knots an hour.[1]

City of Chester, 1873.

Line.	Trips.	Cabin.	Steerage.	Total.	Deaths.
Inman . . .	68	3,635	40,465	44,100	22
National . . .	56	2,442	33,494	35,736	35
Guion . . .	55	1,115	27,054	28,569	18
Anchor . . .	74	1,637	23,404	25,041	19
Cunard . . .	70	7,638	16,871	24,509	10

[1] On the average of the first seven voyages the *City of Chester* performed the passage from New York to Queenstown in eight days, eleven

S. S. "CITY OF CHESTER."

But the Inman Company has recently launched from the yard of Messrs. Caird and Company a still larger and more magnificent vessel, the *City of Berlin*, being the longest and perhaps the largest merchant steam-vessel afloat, the *Great Eastern* alone excepted. Her dimensions are: length over all, 520 feet; breadth 44 feet; and depth to spar deck, 37 feet; her gross register is 5500 tons; she is supplied with two direct-acting high and low pressure engines (compound condensing) of 900 nominal, but indicating, as proved on trial, 4799 horse-power; her cylinders being 120 and 72 inches diameter respectively, with a piston stroke of 5 feet 6 inches; she has twelve boilers and thirty-six furnaces; and she has accommodation for 202 first-class passengers, and 1500 intermediate passengers and emigrants.[1]

City of Berlin, 1875.

A list of the Inman Company's vessels on the 1st of January, 1875, will be found in the Appendix.[2]

The success which had attended the British steamers engaged in the trade with the United States, led to further projects for extending this

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hours, and twenty-six minutes. The *City of Richmond*, too, in her first seven voyages made the same passage on an average of eight days, eleven hours, and fifty-eight minutes; the last-named ship, having on one occasion (April 1874) made the run from Sandy Hook (New York) to Fastnet (60 miles from Cork Harbour) in seven days, twenty-three hours.

[1] To these particulars Mr. Inman, in his evidence before the Committee of the House of Commons (Session 1874, p. 185) on tonnage measurement, adds, "the *City of Berlin* is about 40 feet (depth) to the hurricane deck, and about seven feet six inches in addition to the poop, and about seven feet to the captain's bridge above that. . . The depth from the main deck is about twenty-four feet." This ship on her trial trip over the measured mile indicated 5200 horse-power, and an average speed of 14·825 knots per hour.

[2] The *City of Berlin* has just (Sept. 1875) made the two fastest passages across the Atlantic yet on record. See Appendix No. 13, pp. 611–2.

beneficial agency to the British North American Colonies, and induced the attempt to introduce a regular line of steam-ship communication between Liverpool and Canada by means of the natural estuary of the St. Lawrence. Magnificent, however, as this river unquestionably is, when looked on as an artery of commerce between the rich agricultural and mineral districts along its margins, and the vast tracts of fertile country around its lakes, its navigation is attended with many difficulties and presents numerous dangers. Not the least of these arises from the ice, which, on breaking up, is apt to choke the river, and at the same time to cause the elimination of quantities of watery vapour, which, partially condensed by the surrounding low temperature, is converted into dense fog, so thoroughly impervious to the sun's rays, as to bewilder the most skilful mariner, and incalculably to increase the dangers to which voyaging in these waters is otherwise exposed.

Ocean steamers to Canada, 1853.

But the indomitable spirit of British shipowners refuses to recognise dangers or to acknowledge difficulties save with a resolution to combat and overcome them; and so it has fared with the suggestion made in June, 1852, for applying steam-ships to carry on the mail and other rapid traffic with British North America. Previously, the trade between this country and Canada, had been carried on by a superior class of sailing-ships, many of which during its early history were commanded by their owners or their sons. Among these early merchant traders to Canada, Mr. Alexander Allan, the father of the family that gives its name to the present Allan line of steamers, had a prominent place.[1] When the success of screw-

[1] The founder of this firm, Mr. Alexander Allan, a native of Salt-

steamers upon the Atlantic had been assured, the members of the Allan family turned their attention to the advantages to be derived from their employment of such vessels, and established a line of them to run between Liverpool, Quebec, and Montreal during the period of open navigation, and between Liverpool and Portland when the St. Lawrence is icebound.[1]

First Mail Contract, 1852.

Before, however, their vessels were finished, the Canadian Government advertised (June, 1852) for the conveyance of their mails between this country and Canada in summer, and Portland in winter. For this service a contract was concluded with Messrs. McKean, McLarty, and Lamont of Liverpool, who formed a company and opened the line in the spring of 1853, with a vessel of 500 tons register named the *Genova:* the line was continued for about eighteen months by means of the steamer *Cleopatra*, of 1467 tons, and two smaller vessels, the *Ottawa* and *Charity*, and the *Canadian*, the first steamer built for Messrs. Allan, who had chartered her to the company.

coats, North Britain, afterwards removed to Glasgow, and owned a numerous fleet of sailing-ships, one of which in early life he himself commanded. His eldest son, James, followed his example, as did also his third son, the late Bryce Allan, of Liverpool. Other two, Hugh (now Sir Hugh Allan) and Andrew, established themselves in Montreal, where they managed the shipping business of the family, and James, when he retired from the sea, formed with Bryce and their youngest brother, Alexander, the now important branch of their business at Liverpool.

[1] The first four steamers of this firm were built by the late Mr. William Denny, of Dumbarton, and the skill of this eminent builder is evinced by the fact that one of these early steamers, the *Anglo-Saxon*, although designed, for economy of fuel and capacity, for cargo and passengers, rather than for speed, made the passage from Quebec to the Rock Light, Liverpool, in the then altogether unprecedented short time of nine days and five hours.

But the service, which was conducted with varying regularity, proving unprofitable, was transferred to the Allans, who undertook with the fleet they were building, specially for this trade, to carry on a fortnightly service to Quebec in summer, and a monthly voyage to Portland (Maine) in winter, for the annual subsidy of 24,000*l*. The Crimean war, however, occurring in 1854, offered more remunerative employment to the steamers of the fleet of both contractors. And, consequently, the regular mail service by the Allan line (which at the first was designated the Montreal Ocean Steam-ship Company) was not commenced until April, 1856. Since then it has been maintained with unbroken regularity, with the exception of various serious losses, which might almost have been anticipated in the early history of the service, considering the dangerous character of the navigation. From a fortnightly line in summer, and a monthly line in winter, the operations of the company have been expanded into a regular weekly service, supplemented by an additional fortnightly mail service between Liverpool and Halifax, extending during summer to St. John's, Newfoundland, and continued, monthly, during winter by means of an iceboat, between Halifax and St. John's, when the latter port cannot be approached by ocean steamers.

Allan Line of Steamers, 1856.

Extent and capacity of its fleet.

Steamers of the Allan fleet also trade between Liverpool and Baltimore, and a weekly line of this company is maintained between Glasgow and Canada in summer. A list of the Allan steamers will be found in the Appendix:[1] and I must add that they

[1] Appendix No. 14, p. 612.

are now unsurpassed in their efficiency and regularity by any of the Atlantic lines.

Their steamer, the *Hibernian*, built in 1861, was the first in the Atlantic trade, where the deck-houses were covered by a promenade deck, stretching from stem to stern, which prevents a sea, when it breaks on board, from filling the passages between the deck-houses and bulwarks. Indeed, so highly was the plan approved by Government, that the unproductive spaces under this deck were made, by order of the Board of Trade, the subject of a special exemption from tonnage measure by the deck-shelter clause of the Merchant Shipping Act of 1854. Other Atlantic lines adopting this protection obtained like privileges, but, difficulties arising in connection with ships of somewhat different construction which however claimed the same exemption, Government was obliged to abolish all such immunities.

Speed of these vessels.

Some of the vessels of this line are remarkable for their speed. For instance, in October, 1872, the *Polynesian* on her first voyage, made the passage between Quebec and Londonderry in seven days eighteen hours and fifty-five minutes; while her sister ship, the *Sarmatian*, was engaged by Government to convey the 42nd Highlanders to the Gold Coast, in the recent Ashantee war.

The *Hungarian*, one of the earliest of these steamers, made the passage from Quebec to the Rock Light in nine days six hours and thirty-five minutes, or from land to land in six days. Another, the *Peruvian*, completed one of the fastest round voyages on record in any Atlantic line; on the 16th of December, 1864, she left Moville (port of call, near Londonderry in

Ireland, for the Allan boats) at 6.24 P.M., discharged her cargo at Portland (State of Maine, United States), took in her homeward cargo, and sailing, arrived back at Moville on the 10th of January, 1865, at 9.15 A.M., thus making the passage out and home, including detentions at Portland, while discharging and loading her cargoes, in twenty-four days fifteen hours.

In the limited space at my disposal it would be impossible for me to notice all the lines of steamships now traversing the ocean, and I must, therefore, in a great measure, confine my remarks to those which have led the way and have become either famous by their success or conspicuous by their failure, so that my readers may, it is to be hoped, learn in their day and generation, wisdom from them both, seeing, in the former, what they ought to imitate or if possible improve on; in the latter, what they had better avoid and condemn. Thus, in the Parliamentary Report[1] on the "Royal Atlantic Steam Navigation Company," better known as the "Galway line," will be found an account of the brief career of one of the most unfortunate and disastrous of these undertakings.

Having in view the success of the three British lines of steamers to which I have just referred, but at the same time paying no heed to the warning presented by the Collins Company in their endeavours to traverse, with unusual speed, the fickle and stormy Atlantic, a company of English and Irish gentlemen, most of whom had little knowledge and, certainly, no experience of the business they were about to undertake, proposed to the British Government, in

Galway line a failure.

[1] Ordered by the House of Commons to be printed, 23rd of July 1861.

January 1859, to carry Her Majesty's mails from Galway to Portland, Boston or New York, *viâ* St. John's, Newfoundland, or otherwise, for the sum of 3000*l.* per voyage, "such voyage being the passage out and home." The great attraction, however, of the offer lay in the further condition that "they would undertake to convey telegraphic messages from the United Kingdom to British North America and the United States in *six* days, casualties excepted," the Atlantic cable being then only in contemplation: that is, they offered to make the passage between Galway and St. John's, Newfoundland, at all seasons of the year, in the unprecedented short time of six days. A contract based on this proposal was entered into on the 21st April, 1859, to which a table was annexed[1] of the time in which this company further agreed to deliver *letters* at New York and at Galway. With the object of

[1] Time Table.—(A.) Galway to America.

Summer Service—Outward Voyages.

From Galway to New York, during the months of April, May, June, July, August, September, and October	11 days 2 hours
From Galway to Boston, during the like months .	11 „ 16 „

Summer Service—Homeward Voyages.

From New York to Galway, during the like months	10 days.
From Boston to Galway, during the like months .	10 „ 4 hours.

Winter Service—Outward Voyages.

From Galway to New York, during the months of November, December, January, February, and March	13 days.
From Galway to Boston, during the like months .	13 „ 12 hours.

Winter Service—Homeward Voyages.

From New York to Galway, during the like months	10 days 10 hours.
From Boston to Galway, during the like months .	11 „ 2 „

carrying out this contract, the "Royal Atlantic Steam Navigation Company concluded, on the 10th June, 1859, an agreement with Messrs. Palmer of Newcastle, for the construction of two ships at a cost of 95,000*l.* each, and, on the 15th June, they entered into another contract with Messrs. Samuelson of Hull, for the construction of two other ships at a cost of 97,500*l.* each. These vessels were to be built according to lines, plans, and specifications approved by the Admiralty, and were to be delivered within eleven months from the date of the agreements, the commencement of the postal service according to contract having been fixed for June 1860."[1]

The dimensions of these ships were 360 feet long, 40 feet beam, and 32 feet depth of hold. They were each 2800 tons measurement, with engines of about 850 nominal horse-power; in model and equipment they were somewhat similar. Indeed, the *Connaught* and the *Hibernia*, built by Messrs. Palmer, were "precisely the same;"[2] a clause in their agreement with the company requiring, "that each of the said vessels when completed was, on a fair and proper trial thereof, to accomplish a speed at *the rate of* 20 *statute miles per hour* in smooth water, and to consume not more than 8800 pounds of fuel per hour."[3] But, on the trial of the *Connaught*, the Government inspector reported that the speed of this "vessel was about thirteen knots; the average revolutions of the engines, 16·6; the average pressure

[1] See Report of Committee, 1861, p. iii.
[2] See Evidence, Questions 1583 and 1587, p. 139.
[3] Question, 1573, Ibid.

of steam in the boilers being 22½ lbs. on the square inch, and the vacuum in the condensers 24½ inches."[1]

Difficulties and differences of various kinds having arisen, none of these vessels were delivered within the time agreed upon, and the company was consequently obliged to start the service with a hired vessel—the *Parana*—which sailed from Galway on the 27th of June, 1860, arriving at St. John's in seven days thirteen and a half hours, and at New York in eleven days seventeen and three-quarter hours after her departure, or fifteen hours and three-quarters behind the contract time for the delivery of the mail bags at her final destination, and one day thirteen and three-quarter hours beyond the stipulated time for delivering the telegraph messages at St. John's. The *Connaught* followed, in her case direct for Boston, on the 11th of July, and was twenty-two and a half hours over time in reaching that place. But serious disasters soon befel these steamers: the *Connaught* was totally lost on her second voyage in October, of this year when approaching Boston, she having, on this occasion, been one day and twenty and a half hours behind time in reaching St. John's. One voyage had, consequently, to be omitted altogether. The second ship belonging to the company, the *Hibernia*, encountering a severe gale on her way from the Tyne to Galway was so thoroughly disabled that she never entered the service at all,[2] while their

Loss of the *Connaught*, 1860.

[1] Question 243, p. 25.

[2] The government inspectors, in their Report, state (Question 256, p. 26): "We surveyed the *Hibernia* in dry dock at Messrs. Laird's yard, at Birkenhead," in reference to the Postmaster-General's communication respecting the leaky state of that vessel, "and we found the whole of

third new ship, the *Columbia*, which sailed for the United States on the 9th of April from Galway, returned in May disabled by ice,[1] after making the slowest passage outwards of any of the fleet, having been ten days seven and a half hours in reaching St. John's, and seventeen days twenty and three-quarter hours before she arrived at Boston.[2]

Rapid passage of the *Adriatic*, 1861.

The steamship *Prince Albert* was chartered to take the place of the *Connaught*, and in February 1861 the Company purchased the *Adriatic*, one of the most famous ships of the Collins line. The transfer of this ship to the British flag does not seem to have reduced her speed or detracted from her celebrated sea-going qualities, for she made the run from Galway to St. John's in six days, the specified time, and, having completed the passage to New York in one day fifteen hours and a quarter less than the contract time, returned from St. John's to Galway in *five days nineteen hours and three-quarters*, perhaps the quickest passage on record from port to port across the Atlantic.[3]

But, having, within six months, lost one of their vessels, while another was disabled by storm, and a third rendered unfit for the mail service in her encounter with ice off Newfoundland, the Company, finding it impossible to raise fresh capital in the face of such disasters, had no course left but to abandon

the 'bolts of the flat keel' and bottom plating, for about 150 feet amidships, very much strained."

[1] Report of Committee, page iv.

[2] Appendix to Report of Committee, page 298, "Table of Voyages."

[3] See Appendix No. 6 to the Report of the Committee of the House of Commons.

their undertaking and terminate their contract in May 1861. The return[1] of the earnings and costs to Government of the Galway line of mail steamers shows a heavy loss to the public, but, though I have no means of knowing the amount of the losses of the company itself during its brief career, these must have been far greater; indeed, it was currently reported that the shareholders lost in eighteen months nearly all, if not the whole, of their capital.

But, however disastrous the results to the American shareholders of the Collins line on the one hand, or to the British shareholders of the Galway line of steamers on the other (both these undertakings being, it should be remembered, largely subsidized), the ardour of private and unsubsidized energy in no way abated. The ocean race for supremacy in the carrying trade of the Atlantic was still maintained; and the struggle continued with quite as much spirit

[1] Paper delivered in by Sir Rowland Hill, K.C.B., 12th July, 1861:—

Statement of the Earnings and Costs of the Galway Line of Mail Steamers.

	£
Sea postage of correspondence (including newspapers and transit letters) from 26th June to 23rd October, 1860, inclusive, when the voyages were suspended (estimated)	1,400

Trips: Out, 7; home, 6 . . Total, 13.
Earnings, 108*l.* per trip.

Cost to Post-Office in same time.

	£
Contract payment (less penalties)	14,764
Incidental payments	500
	£ 15,264

(Signed) *Frank James Scudamore,*
12th July, 1861. Receiver and Accountant-General.

as ever between the American owners of sailing-clippers and the British shareholders of iron screw-steamers. It was a brave fight: but the wooden clippers of America had no chance against the iron screws of Great Britain, although the race was not then so unequal as might appear, arising from the fact that the current expenses of the clippers were far less then than those of the steamers, while their capacity for cargo was far greater. Indeed, for a time, it was questionable whether the clippers did not yield their owners quite as good returns on the capital invested as the steamers. The wooden clipper, however, had reached perfection, (the world having never previously seen a more splendid class of sailing-ships than the "Yankee liners of that day,") whereas the screw, being still in its infancy, moved onwards with the progress of science, improvements in machinery tending to reduce the current expenses and to increase the capacity of the ship by reducing the consumption of fuel, so that the sailing-ships were obliged to succumb. At last, the screw-steamers slowly but surely obtained an almost complete supremacy, and have now no competitors (except among themselves) in the more valuable portion of the carrying trade across the Atlantic.

Struggles between the "clippers" and the iron screw-ships.

The success which had attended the Inman and the Allan lines of steamers induced others to follow their example; and various undertakings of a similar character were started in rapid succession. Thus, with the view of availing themselves of recent legislative measures for the encouragement of mercantile associations, a number of Liverpool merchants and shipowners established, in 1863, the National Steam

National Steam Navigation Company, 1863.

Navigation Company with a capital of 700,000*l*. The original intention of the promoters of this undertaking was to provide for the large trade they felt assured must arise between this country and the Confederate States whenever the lamentable war then raging in America should have exhausted itself, and when peace returning should have showered down its many blessings on that fertile and teeming land; their first plan, therefore, was to carry on a regular periodical line of first-class steam-ships between Liverpool and the Southern States. The anxiously hoped for peace between the contending parties in America did not, however, arrive so soon as they had anticipated, and, as the requisite capital had been obtained, and their ships were ready for service, they sent forth their steamers to compete for a portion of the passenger and goods trade of the Northern States, which the Cunard, Inman, and Allan lines were now carrying on with great success.

The first vessels of the National Company dispatched to ply between Liverpool and New York, were the *Louisiana*, the *Virginia*, and the *Pennsylvania* screw-ships of a gross tonnage, respectively, of 3000 and 3500 tons; at that time being the largest vessels afloat. In 1864, the company added to its fleet the *Erin*, the *Queen*, and the *Helvetia*, each of an increased tonnage. With these six vessels the company was enabled to lay the foundation of so successful a trade that, at the conclusion of the war, the directors found the utmost capacity of their vessels insufficient to accommodate the rapidly increasing traffic between the two nations. In 1865, their fleet was again increased by the further

Their splendid ships.

And complete success.

addition of the *England* and the *Denmark*, of 3723 tons, and these vessels, again, were followed in 1866, by the *France*, of nearly similar dimensions. In 1868, the *Italy*, of 4300 tons, was placed on the line, and was the first in that trade in which engines on the compound principle were placed. The *Holland*, of 3847 tons, followed in 1869. The year 1870 proving to be one of great prosperity to the company, the *Egypt* and the *Spain*, of 4669 and 4512 tons respectively, were added to the fleet. These vessels were built by the Liverpool Shipbuilding Company, and by Messrs. Laird of Birkenhead, and are justly considered very fine specimens of naval architecture.

This Company now maintain a weekly service, leaving Liverpool every Wednesday and New York every Saturday; and a fortnightly service from London to New York *viâ* Havre. Following the example of the Cunard Company, the commanders of the ships are required to navigate at certain seasons within fixed limits of latitude, and to furnish a chart to the Company with the lines of their course during each voyage laid down upon it. Stringent regulations are also issued and enforced, and, to the credit of the Company, they have not during their existence, lost a single passenger through negligence or any accident of the sea.

It is a curious fact that, as a rule, the owners of the principal American clipper lines of sailing-ships were among the last to see that their vessels, however splendid, were being daily eclipsed by the screw steamers of Great Britain. Thus, conspicuous among the lines which bravely contended against the new motive power, and long maintained itself in full force,

may be mentioned the Old Black Ball line, which, when I remember it, a quarter of a century ago, possessed upwards of twenty of the finest sailing-packets I ever saw. They were grand ships of their class, and admirably fitted for the trade in which they were engaged, carrying, during some of the later years of their career, a thousand passengers every week, during the summer months, from our shores to the United States. But even the *Black Ball* was at last obliged to give in, having previously merged into or formed part of the Guion line of sailing-ships, which in their day were equally celebrated for the regularity of their passages.[1] Old Black Ball line.

In 1863, however, Mr. S. B. Guion, the chief owner of the line bearing his name, finding it no longer possible to contend against the screws, though evidently still doubtful of their permanent success, entered into an arrangement to supply, through his old connections and agents in America, the Cunard and National Companies, with emigrants and cargo for their steamers; but in 1866, he and his co-partners, most of whom are citizens of the United States, started a steamship of their own. In August of that year, their *Manhattan*, built in this country of iron and fitted with the screw, to their orders, sailed from Liverpool for New York, being the pioneer of their new fleet of liners. The *Minnesota*, *Nebraska*, *Colorado*, *Idaho*, *Nevada*, *Wisconsin*, and *Wyoming*, vessels each of about 3000 tons, and built of iron, specially for this The Guion line. 1863.

[1] There is still a line of sailing-packets, named the "Old Black Ball" line, trading between Liverpool and New York, sailing from the former port on the 1st and 16th of each month. They are large and fine ships, and are under the management of Messrs. C. H. Marshall & Co.

trade, followed in rapid succession. In 1873, they added the *Montana,* another fine vessel of 3500 tons, to their fleet, which, in 1874, was further increased by the addition of the *Dakota,* and two similar vessels, so that the Liverpool and Great Western Steam-ship Company, better known as the Guion line, already possesses a fleet of very fine steam-ships.[1]

Although the American sailing-packets engaged in the trade between Great Britain and the Northern States were, about the year 1860, obliged, in a great measure, to give way to steamers, they maintained their position undisputed for ten years longer between Liverpool and New Orleans; steamers, it was thought, not being able to compete with sailing-vessels in the transport across the Atlantic of such bulky articles as cotton, the chief article exported from New Orleans to Europe. But in 1870, the American merchants and shipowners engaged in the trade of that place found it desirable, if not necessary, to substitute for some of their sailing-vessels a line of screw-steamers similar in many respects, though smaller, to those of the other lines already described, their merchants forming themselves into an association known as the "Mississippi and Dominion Steam-ship Company (Limited)."

Mississippi and Dominion Company.

This company now trades between Liverpool and New Orleans in the winter when the cotton crops are shipped and, in the summer season, between the former port and Canada with passengers and general

[1] In 1873 the *Wisconsin* made the passages from Liverpool to New York and back in each case within ten days.

cargoes. Like the Guion line, their ships are chiefly, if not entirely, owned by Americans and managed by them. On their passages to the south, they usually call at Bordeaux, Corunna, Lisbon and Havana, and thus secure a considerable number of the emigrant passengers who find their way from the southern portions of Europe to that portion of the New World where the climate is not unlike their own, and where the character of the labour is more in accordance with their habits and abilities than would be that of the Northern States.

But another important line of steamers has been added, which in speed has since surpassed, and in other respects is equal to, any of the great Trans-atlantic lines now competing for the traffic of the New World. The White Star Line, under the management of Messrs. Ismay, Imrie, and Co. who have adopted the name of a once celebrated line of sailing-packets,[1] commenced running their steamers from Liverpool to New York in 1870: they now maintain a weekly communication with these ports, with extra boats available for intermediate sailings as the requirements of the trade demand, the regular days being Thursday from Liverpool (calling at Queenstown, Ireland, on Friday), and from New York on Saturday.

White Star line, 1870.

[1] The White Star Line was originally composed of a fleet of fast sailing American clipper-ships, such as the *Champion of the Seas*, *Blue Jacket*, *White Star*, *Shalimar*, &c., sailing to Australia: to this line, Messrs. Ismay, Imrie, and Co. succeeded, and they still carry it on with similar fast high-classed vessels built of iron, such as the *Belfast*, *British Commerce*, *Knight Commander*, *Houghton Tower*, *Glengarry*, *Knowsley Hall*, &c., and they have applied the title "White Star" to their New York line of steamers.

These vessels, which are nearly uniform in size and speed, were designed and built with a view of affording the public an extra supply of steamers, such as would best attain the three-fold purpose of safety, speed, and comfort; and certainly their performances have realised the objects and expectations of their enterprising owners. Built of iron with watertight and fire-proof compartments, they afford in their strength every guarantee for safety, nor are their owners behind their rivals in the caution exercised to avoid the ordinary dangers of rapid navigation.[1] But speed with them, as with all well-regulated navigation companies, appears to be only a secondary consideration, for, not satisfied with a general regulation, Messrs. Ismay and Imrie, in their own interest, as well as in that of the public, have wisely issued to the commanders of their ships a special manuscript letter[2] reminding them, in the most distinct manner, that the safety of the ship under their charge and of all on board of her must

Strict regulations for safety, &c.

[1] Extract from "Book of Regulations" of the White Star line of steamers:

"The commanders must distinctly understand that the issue of the following instructions does not, in any way, relieve them from entire responsibility for the safe and efficient navigation of their respective vessels; and they are also enjoined to remember that, whilst they are expected to use every diligence to secure a speedy voyage, *they must run no risk which might by any possibility result in accident to their ships. It is to be hoped that they will ever bear in mind that the safety of the lives and property entrusted to their care is the ruling principle that should govern them in the navigation of their ships, and no supposed gain in expedition, or saving of time on the voyage, is to be purchased at the risk of accident.* The company desires to establish and maintain for its vessels a reputation for safety, and only looks for such speed on the various voyages as is consistent with safe and prudent navigation."

[2] See Appendix No. 15, p. 613.

ever be their first consideration. That their ships have attained an average rate of speed hitherto unrivalled, combined with great regularity, may be seen by their logs.[1] Their *Adriatic*[2] has far surpassed

[1] *The First Eleven Passages of the* "BALTIC."

QUEENSTOWN TO NEW YORK. Voyage.		Days.	H.	M.	NEW YORK TO QUEENSTOWN. Voyage.		Days.	H.	M.
1. September,	1871	8	19	52	1. October,	1871	8	15	3
2. February,	1872	9	19	22	2. March,	1872	9	3	38
3. March,	„	8	18	32	3. April,	„	8	3	58
4. April,	„	9	3	52	4. May,	„	8	20	10
5. May,	„	8	14	35	5. June,	„	8	22	20
6. June,	„	9	4	52	6. July,	„	8	19	8
7. August,	„	8	13	57	7. August,	„	8	12	8
8. September,	„	8	14	40	8. September,	„	8	10	53
9. October,	„	8	17	52	9. October,	„	8	11	50
10. November,	„	10	17	12	10. December,	„	7	23	22
11. December,	„	10	8	11	11. January,	1873	7	20	9

[2] *Copy of the* "ADRIATIC'S" *Log.*

QUEENSTOWN TOWARD NEW YORK.

Date.	Winds.	Courses.	Distance.	Latitude.	Longitude.	Weather.
1872. May 16	.. ..	..	Left	Liverpool	..	5.10 P.M., Rock Light abeam.
„ 17	.. ..	..	Left	Queenstown	11·05	A.M., Roche's Point abeam.
„ 18	E.N.E.	W.	381	North. 51·22	West. 18·12	Fresh breeze and fine weather.
„ 19	Northerly	S. 87 W.	348	51·13	27·27	Mod. breeze and fine weather.
„ 20	Northerly	75	366	49·31	36·42	Calm.
„ 21	N.N.W.	72	353	37·44	45·11	Light breeze; dense fogs at times.
„ 22	N.N.W.	62	362	44·57	52·57	Mod. breeze; dense fogs at times.
„ 23	W. by N.	78	333	43·20	60·21	Light breeze; dense fogs at times.
„ 24	.. ..	68	357	41·08	67·51	Ditto, ditto.
„ 25	To S. Hook,	..	278	.. ..	..	Anchd. off Sandy Hook, 6 A.M.

THE WHITE STAR S.S. "BRITANNIC."

the famous American steamship of that name which once belonged to the Collins line, she having attained the extraordinary speed of 455 statute miles in one day.[1] Nor has the comfort of the passengers been in any way neglected.

Britannic and Germanic.

At page 278 I furnish a drawing of their newest vessel; and for the information of my nautical readers I may state that the *Britannic* and *Germanic*[2] are similar in all respects. These vessels were built of iron by Messrs. Harland and Wolff, Belfast.[3]

Their great speed.

The engines of the *Britannic* are by Maudslay, Sons, and Field; they are 760 nominal, but indicated 5090 horse-power on the trial trip. They have four inverted cylinders, the high pressure above the low; the diameters of the cylinders are 48 inches and 83 inches respectively, and the length of stroke 5 feet. The pressure of steam is 70lbs. per square inch, and the boilers, eight in number, are fired at both ends with thirty-two furnaces. The propeller has four blades, and is 23 feet 6 inches in diameter, with 28 feet to 31 feet 6 inches pitch. The mode of lifting the screw is novel, as may be seen by the drawing on the following page.

[1] See Appendix No. 16, p. 614, for particulars of this passage.

[2] The *Germanic* (June 1875) made the passage from Queenstown to Sandy Hook in 7 days, 23 hours, and 7 minutes actual time. See details of her log, Appendix No. 17.

[3] The following are some of the principal dimensions of the *Britannic*:

	Feet.	In.
Length between perpendiculars	455	0
„ over all	468	0
Breadth of beam	45	3
Depth of hold	34	0

Net register tonnage . . . . $3,174\frac{15}{100}$ tons.

She has accommodation for 1,300 passengers, and 150 crew.

Details of *Britannic*, and form of her screw.

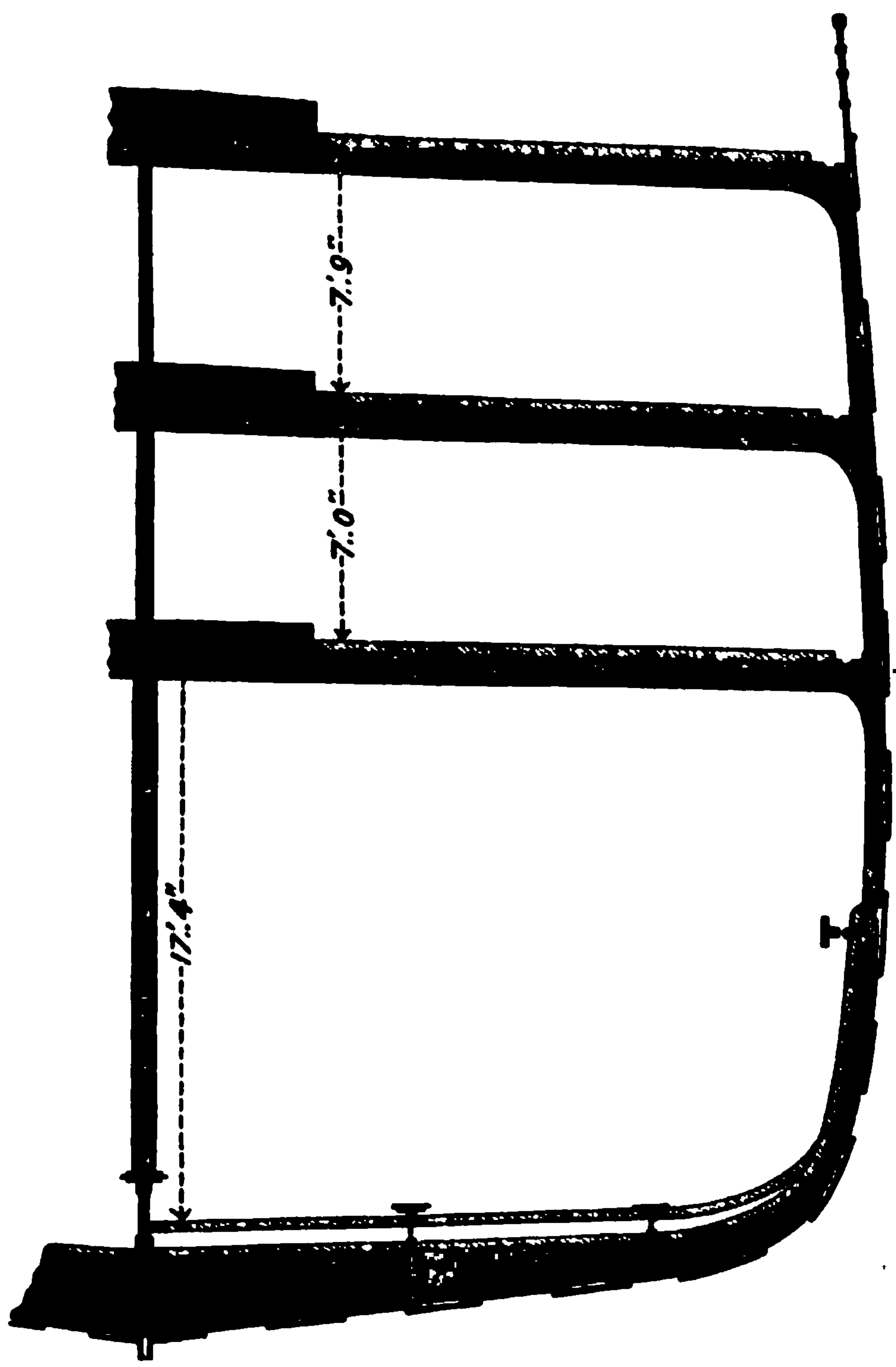
The plan is that of Mr. Harland, the senior partner of the firm by whom the *Britannic* was built. His reasons for introducing this new principle (which he styles, "a lifting-propeller") are, that in long ships, the pitching in a heavy sea way and the vertical motion of the waves tend to expose the upper portion of the screw as usually fitted, the evil effects arising from this being the 'racing' of the engines and its attendant dangers, together with a diminished speed of the vessel.[1]

It is possible, also, that a further advantage may be derived from the fact that, as one-half of the propeller works below the vessel's bottom,[2] there is a somewhat denser medium of water for it to work against, con-

[1] *Engineering*, weekly journal, London, 20th November, 1874.

[2] On arriving in shallow water or nearing a port the screw is raised, so that the bottom of it is above the level of the keel, and when the blades require examining or replacing, the shaft can be raised still higher, thus exposing the boss and allowing ready access when the ship is in light trim. The last two lengths of shafting are connected with an universal joint which works in a chamber in the after end of the tunnel and is at all times accessible to the engineers. The bush is guided by two cheeks on the stern-post, and raised by means of rods with gearing on the middle deck either by a steam-engine or by a hand winch placed on the upper deck, additional power being always at command through the medium of the capstan. The want of the customary keel pieces joining the inner and outer stern-post conveys an

sequently affording (but to what extent, my limited scientific knowledge will not allow me to offer an opinion) the means of obtaining, as I conceive, an increased power of propulsion.[1] But into such questions as these I will not enter, as I prefer stating the facts



appearance of weakness, but this is amply compensated by the increased width and additional thickness at the head of the screw aperture; and the centre of effort of the rudder being raised above the ordinary height. A false foot is fitted to the bottom of the rudder-post and this foot can be readily removed, allowing the screw boss to be changed without disturbing the shaft, which is another very important feature." —*Ibid.*, 20th November, 1874.

[1] Messrs. Ismay, Imrie, & Co. state: "With regard to the *Britannic's* screw propeller, it can be worked at any depth, and need not be stopped whilst the lowering or raising is being proceeded with."

and furnishing an account of what has been done, leaving others more competent than I am to deal with them. As scientific men may consider another question of still greater importance, the best form for the midship section of a steamship, to which I have already referred, I furnish (see page 281) a sketch, drawn to scale and supplied by her owners, of the midship section of this magnificent vessel, and, without further comment, give an account of her performances on her first voyage across the Atlantic.[1]

"The average speed of the *Britannic* is fifteen knots per hour on a consumption of 75 to 80 tons of coals per day, and her approximate cost, built without contract, is 200,000*l*."[2]

[1] *Abstract of Log, S.S.* "BRITANNIC."

FIRST VOYAGE FROM LIVERPOOL TOWARDS NEW YORK.

Date	Direction of Wind.	Course.	Distance.	Lat.	Long.	Remarks.
1874.			Miles			
June 25	..	..	..	..	..	Left Liverpool, 5 P.M.
" 26	..	..	..	..	..	Anchored in Queenstown Harbour, 11.35 A.M. Proceeded at noon.
" 27	N.W.	Various.	350	51·20	17·16	Moderate breeze and fine weather.
" 28	S.E.	S. 87 W.	351	51·05	26·34	Moderate breeze, cloudy, with head sea.
" 29	N.E. to S.	S. 76 W.	352	49·38	35·25	Light breeze, with cloudy weather.
" 30	W.N.W.	S. 72 W.	351	47·49	43·39	Moderate breeze, cloudy, with head sea.
July 1	N. to N.E.	S. 66 W.	367	45·22	51·42	Moderate breeze, with dense fog.
" 2	N.E.	S. 66 W.	375	42·52	59·34	Moderate breeze, and cloudy.
" 3	E.S.E.	S. 72 W.	376	40·56	67·32	Light breeze, and dense fog.
" 4	..	Various.	285	..	..	Sandy Hook abreast at 9.15 A.M.

[2] Letter from Messrs. Ismay, Imrie, and Company, 3rd December, 1874.

These steamers run in connection with the Erie Railway from New York (as do also other of the lines) booking their passengers through to all parts of the United States, as far as Aspinwall and San Francisco, and also to Canada. As their arrangements and scale of provisions for steerage passengers are, in nearly all respects, the same as that of the other Transatlantic lines, a copy is furnished for the information of my readers, together with the conditions on which alone passengers are received.[1]

Recently an American Company have with great spirit sent forth from their own country, a line of

[1] "Passengers will be provided with berths to sleep in, each adult having a separate berth; but they have to provide themselves with a plate, mug, knife, fork, spoon, and water-can, also bedding. Married couples, with their children, will be berthed together; females will be berthed in rooms by themselves.

"*Bill of fare.*—Each passenger will be supplied with three quarts of water daily, and with as much provisions as he can eat, which are all of the best quality, and which are examined and put on board under the inspection of her Majesty's Emigration Officers, *and cooked and served out by the company's servants.*

"*Breakfast at eight o'clock.*—Coffee, sugar, and fresh bread and butter, or biscuit and butter, or oatmeal porridge and molasses.

"*Dinner at one o'clock.*—Soup and beef, pork, or fish, according to the day of the week, with bread and potatoes, and, on Sunday, pudding will be added.

"*Supper at six o'clock.*—Tea, sugar, biscuit, and butter. Oatmeal gruel will be supplied at eight P.M. when necessary.

"*Luggage.*—Ten cubic feet will be allowed for each adult steerage passenger, and twenty for each adult saloon passenger, free; for all over that quantity a charge of 1*s.* 6*d.* for each cubic foot will be made.

"All passengers are liable to be *rejected* who, upon examination, are found to be lunatic, idiot, deaf, dumb, blind, maimed, infirm, or above the age of sixty years; or any woman without a husband with a child or children; or any person unable to take care of himself (or herself) without becoming a public charge, or who, from any attending circumstances, are likely to become a public charge. Sick persons or widows with children cannot be taken, nor lame persons, unless full security be given to the United States' Government, that the parties will not become chargeable to the State."

steamers to trade between Philadelphia and Liverpool.[1] They consist at present of the *Pennsylvania*, *Illinois*, *Ohio*, and *Indiana*, each of about 3100 tons gross, or about 2000 tons nett register; they are all built of iron, on the Delaware (U.S.), and are fitted with screw-propellers. The *Pennsylvania*, launched 1873, cost, according to the statement of her owners, "ready for sea, about 600,000 dollars" (120,000*l.*); who add that, "if built on the Clyde of as good materials, the saving would have been trifling." In any attempt, however, to estimate the cost of a steamship I may state, for the information of non-nautical readers, that the outlay on one vessel, even of a similar grade or class, when built for the conveyance of passengers as well as cargo, gives but an imperfect idea of the cost of another vessel, of the same tonnage but not so appropriated. If we take simply the hull, the power of the engines, and the ordinary outfit for a sea-going ship of a particular class, the comparative cost of constructing such a vessel in different countries, or even at different ports in any one country, may be easily ascertained, but, in a passenger-ship so much depends on the quality of the outfit and furnishing, and, especially, on the cabin accommodation, varying as these do almost as much as from a cottage to a palace, I should certainly mislead my readers were I to attempt to supply a comparative cost of passenger-ships built in America and in England.

Difficulty of estimating the real cost of steamers.

[1] In 1866, an American company started a line of steamers between Boston and Liverpool. Two large and elegantly fitted wooden screws built in Boston, named the *Erie* and *Ontario*, were the precursors of this line, but were so unfortunate that, after making two or three passages across the Atlantic, the enterprise had to be abandoned.

The vessels of this line are each 355 feet in length, with 43 feet beam, and 33 feet depth of hold. They have each accommodation for 76 first class, and for 800 intermediate and steerage passengers. The actual steam-power of each of these vessels is given as "2800 horse-power indicated," but this furnishes, as I have before stated, but a vague idea of the nominal power on which the cost is based, as the actual power depends on the dimensions of the engines, the mean pressure on the piston, and the speed with which the engines move. On the other hand, nominal horse-power is fixed by certain arbitrary rules. Pennsylvania Company, 1873.

Though the Philadelphia line of steamers has much to contend against, owing to duties imposed by the American Government on all articles required for their construction and outfit, and may, consequently, find it difficult to rival successfully the steam-ships of Europe engaged in the Transatlantic trade, they are supported, if not owned, by one of the largest railway undertakings in the United States of America. The lines of this company cover more than 6000 miles of communication within the interior, extending over States which produce the breadstuffs of the north as well as the tropical fruits of the south with a teeming and almost virgin soil, sufficient in itself to produce cargoes for a fleet of ships far in excess of that it as yet possesses, and affording fields of remunerative employment for hundreds of thousands of persons now huddled together in many of the over-peopled countries of Europe.

Indeed, from the accounts which reach us, the valley of the Mississippi in itself still affords room, and, in time, will give profitable employment for

100,000,000 persons, and if the industrious and frugal of our own people and of Europe, are unable to gain a living by honest means in the land of their birth, they will find, sailing daily from the port of Liverpool, alone, at the present moment, as also from other ports, steam-ships [1] of the finest description, ready to convey them in a hitherto incredibly short space of time, to the United States of America, and at a cost very little more than they would require for their main-

[1] In the Appendix No. 17, pp. 617–632, will be found a table of the several passages of the steamers of some of the lines employed in the Trans-atlantic trade during the years 1873 and 1874. I must, however, add (as I am anxious to be impartial and strictly accurate), that the steamers of three of these lines, the "Cunard," "Inman," and "National," adopt the "Lane route," that is, the route to the south of the Newfoundland banks, which increases the distance of each passage by about 90 miles, or allowing for the favourable Gulf stream by from 50 to 60 miles. I must also direct the attention of my readers to certain figures in these returns where I have placed an asterisk. For instance, one of the Cunard steamers (the *Cuba*) was on the passage of the 19th January, 1873, about seven days beyond her usual time, no doubt arising from some uncontrollable cause, which would increase the average passages outwards of the steamers of this line for that year by about 3 hours 10 minutes. Similar remarks apply to the steamers of the other lines, as the increased time there noted affects the annual average length of their passages, also, in a greater or less degree. The *Canada* (National line), 16 January, 1873, was, for instance, about seven days, while three other vessels of this line were three and a half, six and a half, and six days respectively behind their usual time. The *America* (Bremen line) was on one passage more than eleven days. A steamer of the White Star line, on one occasion, four and a half days; while the Guion line, on four occasions, four, five, six, and ten and a half days respectively; and the Inman line, four and a half, three and a half, four and a half, and ten days respectively longer than their usual time, occasioned, I am informed, by serving ships in distress and other laudable or unavoidable causes. Though some are faster than others, the speed and regularity with which all these lines of steamers traverse the Atlantic is very remarkable, and no better illustration could be given than this table of the perfection we have reached in ocean navigation. Indeed, the time of the arrival of these vessels can be depended on with almost as much certainty as a railway train.

tenance at home, during a similar period of time to that occupied on the passage.

But, besides the magnificent lines of steamers which now connect, *viâ* Liverpool, the Old and New Worlds together by a ferry, easier of accomplishment, and attended with less danger than was even the passage between England and France half a century ago, there are other important lines of steamers from Glasgow and London, as well as from various continental ports, which I must notice. Not the least important of these is the Anchor line from the Clyde, one of the many extraordinary developments, during recent years, of our maritime power, and entirely due to individual energy. Within only a few years Messrs. Henderson Brothers, the managing owners of the Anchor line, have created a fleet of steamships of 71,328 gross tons and of 15,147 horse-power.[1]

Anchor line from the Clyde, 1856.

Though this line was established by Messrs. Handyside and Henderson in 1856 (their vessels then sailing from Glasgow to Quebec and the Mediterranean ports), it was not until 1865 that their owners commenced regular communication, every fortnight, between Glasgow and New York. Since then the service has been gradually increased, and a steamer is now dispatched, at all seasons, weekly each way, and, during summer, twice, and occasionally three times a week, according to the demands of the trade. Like many other gigantic concerns, this one had a very humble beginning. Commencing with only one or two vessels, they were steadily and rapidly increased on the well-founded anticipation

[1] See Appendix No. 18, p. 633.

Prodigious range of their trade operations.

of a successful trade. With the increase of the New York branch of the service, that of the Mediterranean increased also. Indeed, it supplies the main or American line with a considerable portion of its most valuable employment, and now runs weekly to Lisbon, Gibraltar, Marseilles, Genoa, Leghorn, Naples, Messina, and Palermo; fortnightly to Trieste and Venice; and monthly to Algiers, Tunis, Malta, and Alexandria, thus connecting the whole of the ancient trade of Spain, of the Italian Republics, and of far-famed India itself, with the New World through the medium of the Suez Canal[1] and the Mediterranean.

The Anchor Company also despatches steamers, weekly, during the season of open navigation, to Christiania, Christiansund, and Gottenburg, thus securing another valuable feeder to the New York line of steamers. The Scandinavian and other passengers from the extreme north of Europe are brought across from Gottenburg, to Granton (near Edinburgh) in two days, or from Christiansund in a day and a half, and, as Granton is only about two hours by rail from Glasgow, they can embark on board the Anchor line of steamers for the United States or for Nova Scotia and New Brunswick, on the third day after leaving their homes in the far north.

[1] These steamers, which sail monthly from Glasgow for Alexandria, run in connection with the Peninsular and Oriental, and British India Steam Navigation Companies, by means of which system, passengers can be forwarded from Suez to Colombo, Madras, Calcutta, Rangoon, and Moulmein, and to all the principal towns in India and China. The Anchor Company has also a monthly service of its own vessels between Glasgow, Liverpool, and Bombay, *viâ* the Suez Canal, taking goods and passengers for the ports on the West coast of India and the Persian Gulf in connection with the British India Company's steamers.

The steamers of this firm also sail from Genoa, Leghorn, Naples, Messina, Palermo, Marseilles, and Gibraltar, once a fortnight, direct for New York, and every month from Trieste and Venice—once the great emporium of commerce in the East—to the still greater commercial emporium of the West; and every fortnight, during the six autumn and spring months, or fruit season, Messrs. Henderson likewise dispatch steamers direct from Malaga, Almeria, Valentia, and Denia to the United States.

In their *Victoria* may be seen a good specimen of **The *Victoria*.** a business ship, perhaps not so swift or so elegantly

ANCHOR LINE S.S. "VICTORIA."

fitted as some of her competitors from Liverpool, or equal to their own latest ships, the *Ethiopia*, *Bolivia*, and *Anchora*,[1] but a vessel well adapted for the trade on which she is employed. The *Victoria* is a sister ship to the *California*, launched from the shipbuilding yard, on the Clyde, of Messrs. Alexander Stephens and Sons, who have constructed a great many vessels

[1] These steamers are each 400 feet in length, 40 feet breadth, and 33 feet depth from upper deck. They measure 4000 tons gross. They can accommodate in their cabins, which are fitted in first-class style, 250, and in the steerage 900 passengers.

for the Anchor Company. She is like all the other steamers now engaged in the Transatlantic trade, built of iron and propelled by the screw.[1] Though of larger capacity, she is said to have cost, complete for sea, somewhere about 100,000*l.* or 20,000*l.* less than the American iron screw ship *Pennsylvania*, to which reference has just been made, which was built about the same time on the Delaware.

Hamburg American Steam Packet Company.

But besides the fleets we have specially named there are other equally fine British steamers, plying between London and New York and Boston direct, and also *viâ* Southampton and Havre; together with various other lines of first-class steamers engaged in the American trade belonging to France, Hamburg, and Belgium, though most of these are British built: for instance, the Hamburg and American Steam Packet Company have a large fleet of high classed steamers, comprising the *Suavia*,[2] *Pomerania*, *Thuringia*, *Hammonia*, *Westphalia*, *Silesia*, *Cimbria*, *Frisia*, and *Holsatia*, which leave Hamburg

[1] The *Victoria* is 361½ feet in length, 40½ feet beam, 24½ feet depth of hold to main, and 32 feet to spar deck; her measurement is 3287 tons gross. She has compound engines of 500 nominal horse-power, with cylinders of 57 inches and 108 inches diameter respectively, having 4 feet length of stroke of piston, and six boilers with eighteen furnaces, consuming, when at full speed, "14 knots per hour on the measured mile, 45 tons of coal per day of twenty-four hours." She has accommodation for 150 first-class and 900 steerage passengers, besides her crew, and also large cargo space.

[2] The *Suavia*, which was built in 1874 by Messrs. Caird and Co. of Greenock, is 361 feet in length, 41 feet in breadth, and her depth to the upper spar deck is 34 feet. She measures 3623 tons gross, and has accommodation for ninety-two first-class passengers, eighty-two second-class and 930 third-class passengers, besides her crew of 120 men; she has likewise space for 2000 tons of cargo. The *Suavia* is the twenty-second steam-ship built by Messrs. Caird and Company for the Hamburg American Steam Packet Company.

every Saturday throughout the year for New York; and another line of eight equally fine steamers, which trade with the West Indies and Mexico every month from Hamburg, calling alternately at Grimsby and Havre.

There are also the steamers of the North German Lloyd's, an old established company, trading between Bremen, Baltimore, and New York *viâ* Southampton and Havre; while, besides those engaged in the trade with the United States, two lines of French steamers, most of which were built in England, now maintain a weekly intercourse between the ports of that country and the West Indies and Brazil. **North German Lloyd's Company.**

CHAPTER VII.

Royal West India Mail Steam Packet Company, 1841—Number of their ships—Conditions of mail contract—Large subsidy—Heavy loss during the first year of their operations—Capital of the Company—Liberal concessions by Government—Complaints of the public—Improved prospects of the company from improved management—Contract renewed, 1850—Its conditions—Fresh conditions, 1857—Contract again renewed, 1864—Further renewal, 1874—The steamship *Forth*—Losses of various ships of the company—Causes of these losses—Loss of the *Amazon*—Terrible sufferings—Loss of the *Demerara*—Additions to their fleet, and superior class of vessels.

Royal West India Mail Steam Packet Company, 1841.

SOON after the Atlantic Ocean began to be regularly navigated by steam-vessels, the importance of a better means of intercommunication with the West Indies led to the formation of the Royal Mail Steam Packet Company, which entered into a contract with the Board of Admiralty in March 1841 for the conveyance of the mails between England, the West Indies, and the Gulf of Mexico. This company commenced operations on a much more comprehensive and grander scale than either the Cunard Company or the Peninsular and Oriental. Fourteen large steamships were at once ordered to be built for the service; they were to be substantial and efficient in all respects, and of such strength as would enable them to carry guns of the largest calibre then in use on

Number of ships.

board Her Majesty's war-steamers, with engines of not less than 400 collective horse-power.

When complete, the conditions of the contract required one of these vessels to be ready to take the mails on board, twice in each calendar month, and to proceed, *viâ* Corunna and Madeira, to the island of Barbadoes and, after staying there not more than six hours, thence, *viâ* St. Vincent, to the island of Grenada, where the stoppage was limited to twelve hours, and thence, again, to the islands in succession of Santa Cruz and St. Thomas, Nicola Mole in Haiti, Santiago de Cuba, and Port Royal, in Jamaica. After a stay not exceeding twenty-four hours at Port Royal, the steamer was to proceed to Savannah-la-Mer, in the same island, thence to Havannah, and, on her return thence, to call again at Savannah-la-Mer, thence to Port Royal, and, thence, to Santiago de Cuba, Nicola Mole, and Samana, in the island of Haiti, delivering mails at each place, "care being taken that the said steam-vessel shall always arrive at Samana aforesaid (after performing the said voyage from Barbadoes under ordinary circumstances of wind and weather) on the twenty-second day after the arrival from England of the mails at Barbadoes;" and, after delivering and receiving the mails at Samana, "the steam-vessel shall make the best of her way back from Samana to such port in the British Channel as the said Commissioners of the Admiralty shall from time to time direct." The scheme, also, embraced other places in the West Indies, the Spanish Main, and the United States, for which mails were to be carried. In consideration of the services thus to be performed, the company was

Conditions of mail contract.

Large Subsidy.

to receive at the rate of 240,000*l.* per annum, in quarterly payments; the contract to commence on the 1st of December, 1841, or at an earlier day if possible, and to continue in force for ten years, subject to twelve months' notice on either side for its termination.

But this subsidy, large as it doubtless was for the service to be performed, was not sufficient to cover the heavy outlay the company had considered necessary in the construction and equipment of their fleet. Perhaps, too, part of this outlay arose from the fact that, though Mr. McQueen, the projector of the company, was a gentleman who had had considerable experience in the promotion of large undertakings, his knowledge of maritime affairs was limited, while he was not sufficiently conversant with those details, the practical knowledge of which is so essential to the success of all shipping operations. The directors, as a body, were not competent, from previous experience, to manage such an undertaking; while the choice also of commanders, selected from the Royal Navy, with little or no experience of steam, and none whatever of the numerous requirements of a merchant-ship, was unfortunate, and may have in some measure tended to produce a balance sheet which, though embracing to its credit the large permanent subsidy, showed at the close of the first year's operations a loss of no less than 79,790*l.* 16*s.* 8*d.* to the company!

Heavy loss during the first year of their operations.

It may, however, be remarked that the projectors of this undertaking had entered on an entirely new field, and that merchants who had been accustomed to dispatch their produce in sailing-vessels were unprepared to pay the enhanced rates required for

steam-ships, while the passenger and goods trade in itself was not then nearly sufficient for a remunerative return on the large capital subscribed.

Capital of the Company.

Originally, the company was authorized to issue fifteen thousand shares of 100*l.* on which calls of 50*l.* per share had been made up to the time of the first meeting of shareholders, with power to borrow 260,000*l.* But as another call of 10*l.* per share, sanctioned at this meeting, was found insufficient for the requirements of the Company, the directors appealed to Government for further assistance. By the original arrangements, the annual mileage traversed by the company's ships would have been 684,816 miles. Government, however, in reply to their appeal, generously consented to reduce the distances to be performed to 392,976 miles, and to allow the annual subsidy of 240,000*l.* to remain undisturbed. By these important and liberal modifications the annual expenditure of the company which, according to their own calculations, would have been 360,000*l.* per annum, was reduced to 235,000*l.*

Liberal concessions by Government.

It was further conceded that if, at any time, and from causes, in the opinion of Government, of a public and national character, such as war, the insurance on steam-vessels should rise above six guineas per cent. per annum, or on coals above two guineas per cent. on the outward passage, the company was to receive an additional sum to be settled by arbitration, but which was not to exceed 10,000*l.* per annum.

Complaints of the public.

In process of time, and notably after the necessity of greater economy in the public finances had been admitted, great discontent was expressed through

the press with regard to these very liberal concessions,[1] which was materially aggravated by a statement, the accuracy of which I have no means of testing, that the amount paid for the West India mail service exceeded the sum received for postage by 183,938*l*., and that, though the Brazil branch left a margin of 3478*l*. in favour of the Post-office, the direct loss to the public amounted to no less than 180,460*l*. per annum.[2]

To most of these complaints the company was altogether indifferent, believing them to have their origin in disappointment and jealousy; but there was no answer to the well-founded remonstrances of the colonists that the service was, after all, performed with great irregularity. Indeed, it is beyond cavil that during their earlier operations, the vessels did not arrive at the time named in the tables of routes attached to the contract, that, for instance, the duplicate correspondence from Chagres, sent round by way of New York in American vessels, and thence by the Cunard or American steamers to Liverpool, often arrived in England sooner than the original letters brought directly by the Royal Mail vessels; and, further, that much confusion was constantly caused by the non-arrival of the outward mails till days after the dispatch of the homeward ones. Unnecessary delays also took place in coaling at St. Thomas and in the receiving and transferring freight there and elsewhere. There was also, it was alleged,

[1] See articles in the *Civil Engineer and Architects' Journal*, 1862, pp. 174 and 242, and other journals of the period.

[2] It should, however, be added that these figures apply to an estimate made during the time of high postage rates, when as few letters as possible were sent through the Post-office.

a want of sufficient steamers for the intercolonial service, while the occasional negligence and incompetency of the commanders of the vessels led to a needless loss of time between port and port; complaints were likewise made of insufficiency of accommodation for passengers on some of the intercolonial steamers, and, also, that a pernicious system of gambling was permitted in the vessels of the main line. Some of these complaints, as frequently happens under similar circumstances, were frivolous and unwarrantable, but too many of them were unanswerable; indeed the bitter attacks on the company might naturally have been expected considering the numerous favours supposed to have been conferred on it, and, above all, the notorious fact, that the contract for the conveyance of the mails was never exposed to public competition.

On the other hand, the company had great difficulties to contend against, while its shareholders, so far from receiving any dividend on their capital, sustained during the first year of its operations a heavy loss. Moreover, though liberal concessions had been made by the Government, together with various unusual allowances, these were more than counterbalanced by the loss of two valuable ships during the second year of its operations. Yet, taking into account these and other losses, to which reference will hereafter be made, the trade increased so rapidly as to recoup the disasters of the company, and to leave, in 1843, a surplus of receipts over expenditure of 94,210*l.* and in 1844 of 147,749*l.*: the directors were therefore enabled to recommend a dividend on the half-year

Improved prospects of the Company

ending 31st December, 1844, of 30*s.* per share; in October, 1846, 35*s.*; and in April, 1848, 2*l.* per share.[1]

From this time the prospects of the company steadily improved, and when, in 1850, various capitalists in the United States projected the construction of a railway across the isthmus of Panama—a project which promised extensive additions to its business—the company was in a position to render this new undertaking considerable assistance by advancing, in the course of the year 1851, the sum of 25,480*l.* towards its completion. At that time, too, the direct and most advantageous route to the Australian colonies appeared to be across that Isthmus; indeed the Panama route was recommended by a Committee of the House of Commons who inquired into this subject in the session of 1849. But, apart from the Australian trade, that of San Francisco was then being rapidly developed by the discovery of the gold mines, by attracting (as these did) large numbers of passengers from Europe, and, thereby, laying the foundation of the present enormous traffic in grain and other produce from California, perhaps the most fertile district of the United States—the valley of the Mississippi not excepted.

from improved management.

From that period the operations of the company have from various causes yielded a very fair return to its shareholders, some of these, doubtless, being due to the rapid increase of the trade, to the knowledge the directors have gained from experience, and, not the least, to the fact that their ships are now commanded by men who have been either trained in their own

[1] "Our Steam Fleets," *Liverpool Journal of Commerce*, October 26th, 1874.

service, or have acquired, while employed by other shipowners, the sort of knowledge essential for the successful management of merchant-steamers.

In 1850, Government granted a renewal of the mail contract to the company for a further term of ten years from the 1st January, 1852, the conditions being, that the subsidy should be raised from 240,000*l.* to 270,000*l.* per annum, and that the company, on its part, should undertake the additional cost and expense of a monthly service to the Brazils, thus increasing the mileage to be performed from 389,448 to 547,296 miles, and, at the same time, reducing the mileage rate from 12*s.* 3*d.* to 9*s.* 10*d.* per mile. The company was also required to accelerate the speed on the West Indian line from 8 knots an hour, as originally agreed, to 10 knots an hour, and to add five new steamers to their fleet, each of 2250 tons burden and 800 horse-power. Besides an increased outlay of capital, these conditions entailed on the company a very considerable increase in the wear and tear of ships and machinery; hence their general expenditure rose in the course of the year, after these new arrangements came into force, from 264,802*l.* to 403,769*l.* per annum. **Contract renewed, 1850. Its conditions.**

In 1857, other changes were made in their contract. The first condition—a somewhat extraordinary one—had reference to an amalgamation with the European and Australian Mail Company for the conveyance of the mails, *viâ Egypt*, to and from Australia, which subsequently proved a great failure, this Company having altogether broken down; the second required an acceleration of the mails between England and Rio Janeiro from sixty-six days twenty-two hours, **Fresh conditions, 1857.**

the time hitherto allowed for the performance of the round voyage, to fifty-five days nineteen hours. The company was, also, ordered to provide three more vessels, of 3000 tons and 800 horse-power, for the West India and Atlantic service, and a fourth of smaller dimensions to increase the speed of the mails between Rio Janeiro and the River Plate. These changes proved to be of considerable public advantage, as the time of the post between England and the isthmus of Panama was thus reduced from fifty-nine to forty-two days, while, as the homeward mails arrived three days before the departure of the outward ones, the mercantile community obtained important additional facilities for transacting their business with that part of the world.

Contract again renewed, 1864.

When the second contract expired in January 1864 fresh arrangements were made whereby the annual subsidy was reduced to 172,914*l.* and the speed increased on the West India Transatlantic service to 10½ knots an hour. In 1866 it was further agreed that each alternate fortnightly packet should proceed from St. Thomas direct to Colon instead of touching first at Jamaica, thus shortening the route between England and Panama. In 1868 another and, in this case, most important modification, was suggested in the conditions of the contract. Hitherto, the steamers of this company had been propelled, principally, by paddle-wheels, its directors being, perhaps, among the last to see the advantages to be derived from the application of the screw. But, though now convinced of the many advantages of the screw over the paddle, before entering on the large expenditure required for such a change, they naturally wished to know the

intentions of Government with regard to the continuation of their mail contracts; the result of this application being the extension of the period till 1874, with, however, the condition, that Government should participate in all profits beyond eight per cent.

As a considerable amount of discontent had, in the meantime, again found expression through the medium of the public press with regard to the very large sums of money which this company had received for the conveyance of the mails, and, as different members of the House of Commons had insisted that the service should be thrown open to public competition, the directors were obliged to consider the alternative of either abandoning it altogether, or of conducting the service for a much less amount than they had hitherto received: they wisely adopted the latter course, and, on public tenders being invited, undertook to convey the West India mails for the annual subsidy of 84,750*l.*, not much more than one-third of what they had originally received—a sum, however, subsequently supplemented by 2000*l.* per annum as a recompense for the ships calling at Plymouth and there landing the mails, instead of at Southampton, their final port of destination.[1] **Further renewal. 1874.**

[1] "The mail services of the company on the West India, and Brazil and River Plate lines are now (1875) carried on under arrangements with the Government, involving a still further reduced subsidy;" and the Directors in their report of the 28th April last add :—

Since the last Report a contract has been entered into by the Company with her Majesty's Government to carry on the Brazil and River Plate Mail Service, from the 1st January, 1875, for a payment according to the weight of letters, etc., conveyed by the packets. The contract is terminable at six months' notice on either side, and is for a service twice a month from Southampton; the vessels, which have for a considerable time past left on the 24th of the month, being thus placed on the same footing as those dispatched by the company under the previous contract on the 9th of the month."

In subsidizing the Royal Mail Steam Packet Company during the earlier portion of its career to the large extent I have named, the British government were evidently actuated by reasons similar to those, which induced the government of the United States to make the like liberal concessions to the unfortunate Collins line; and there can be no doubt that the original vessels of this company were well adapted for one of the objects Government had then in view—the creation of a fleet of a class of large and strongly built merchant-steamers, which could be made use of in the event of war. Hence, all these vessels were built to carry heavy guns when necessary, so as to be serviceable for the purpose of the navy at a comparatively small subsequent outlay. A drawing is furnished on the following page of one of those ships which, in nearly all respects, resembled the government steamers of the period.

The steam-ship *Forth.* The *Forth* was altogether a very fine vessel of her class, and the largest of any of the original fleet of the company. She was somewhere about 1900 tons gross, or builders' measurement, 1147 tons register, and 450 nominal horse-power. She was built at Leith in 1841, by Messrs. Menzies and Co., and, as Government reserved its right of purchasing any of these ships at a valuation, she was, like the others, constructed in accordance with a specification from the Admiralty, under the survey and immediate control of officers appointed for this purpose. Indeed, the fleet of the Royal Mail Company consisted of the finest class of vessels of that description built of wood which, previous to 1841, had been sent to sea either for naval or mercantile purposes. Nor were they

inferior to any vessels then afloat either in the completeness of their equipment, or in the elegance and convenience of their accommodation for first-class passengers. But, from some cause or other, arising either from those I have already ventured to suggest or from the unavoidable dangers of the ocean, the company at first was most unfortunate in the

S.S. "FORTH."

Losses of various ships of the company.

number of losses they sustained Nor can it be urged that such disasters were due to any special dangers in their line of navigation, for they had no fogs and ice to fear, like their more northern Transatlantic voyagers: with the exception of occasional hurricanes among the West India Islands, their course was a comparatively safe one, and, yet, no fewer than six of the West India Royal Mail Company's packets were lost in the first eight years of their career.

Besides the *Isis* which, on the 8th of October, 1842, sank off Bermuda, having previously struck on a reef, the company lost, on the 15th of April, 1843, the *Solway*, 20 miles west of Corunna. She was one of their finest vessels. Her captain, the surgeon, various passengers, and a portion of the crew, consisting in all of sixty persons, perished with the ship. The *Tweed*, another of their first-class vessels, of 1800 tons burden and 450 horse-power, was totally lost on the 12th of February, 1847, on the Alicranes reefs off Yucatan, in the Gulf of Mexico, while on her voyage to Vera Cruz. Her loss was most disastrous, and caused great excitement at the time. The crew and passengers amounted to 151 persons (seventy-two of whom were drowned), and their sufferings, as graphically described by one who had escaped,[1] formed a subject of conversation for a longer period than such calamities now do. After five days' suffering, the remainder of the passengers and crew were rescued from the barren reef of rocks on which they had been cast. Again, on the 1st of February, 1849, the *Forth* was also completely lost on the same rocks which had caused the total destruction of the *Tweed*; while, in the following year the *Actæon* was wrecked in rounding the point near Carthagena on a shoal extending, as was alleged, much further into the sea than had been laid down on the Admiralty charts. Nor must the loss of the *Medina*, wrecked on the 12th of May, 1844, on a coral reef near Turks Island, be omitted, as this was, certainly, one which ought not to have occurred.

[1] *Vide Times* newspaper, 9th April, 1847.

Some of these disasters, no doubt, arose from the intricate nature of the navigation among the West India Islands, and others may have been caused, as the supporters of the company alleged, "by those sudden changes of the weather, hurricanes, squalls, northers, &c., with which the West India Islands, Spanish Main, and Gulf of Mexico are so frequently visited," but the rocks and shoals of the Gulf could have had nothing to do with the loss of the *Solway* off Corunna, and, as the company has met with much fewer disasters of late years, I may be allowed to suspect that incompetency had too much to do with the almost periodical losses of the first eight or ten years of its career. **Causes of these losses.**

But by far the greatest disaster which befel any of this company's ships was the destruction of the *Amazon* by fire at sea; indeed, nothing could be more terrible than the loss of this ship and the sufferings of those who perished with her. **Loss of the *Amazon*.**

The *Amazon* was built by Messrs. R. and H. Green, at Blackwall, and launched from their yard on the 28th of June, 1851: she was the largest wooden merchant steam-ship which had up to that time been constructed. An illustration of her, as she lay at anchor ready for sea, on her first and only voyage, will be found on the following page.[1]

[1] The dimensions of the *Amazon* were 300 feet in length, 41 feet in width, and 32 feet in depth; she was about 3000 tons burthen or 2256 tons register. Her engines, of 800-horse power, were constructed by Messrs. Seaward and Capel of Millwall, Poplar, the diameter of the cylinders being 96 inches each and the stroke 9 feet. The engines made fourteen revolutions of her wheels (which were 41 feet in diameter) per minute, giving a speed by log of 11 knots an hour on her trial trip, at a draught of 19 feet forward and 19 feet 9 inches aft.

When surveyed by the Admiralty before her departure from Southampton, she was reported capable of carrying fourteen 32-pounders, and two 10-inch pivot guns of 85 cwt. each on her main-deck; her coal bunkers were constructed to carry 1000 tons of coals, or upward of sixteen and a half days' con-

"AMAZON."

sumption at the rate of $2\frac{1}{2}$ tons per hour for her twenty-six furnaces. Her engines were fitted in a framework independent of the vessel, so that little or no perceptible vibration was felt when they were at work: moreover, allowing 12 superficial feet for each man, she had accommodation in her lower decks for 360 soldiers, besides elegant cabins for first-class passengers. Her cost, when ready for sea, was somewhat over 100,000*l.*

On the 2nd of January, 1852, the *Amazon*, under command of Captain Symons, took her departure from Southampton with the usual mails for the British and foreign West Indies, the Gulf of Mexico, Spanish Main, &c., fifty passengers, and a large and valuable cargo. Her crew numbered 110, exclusive of the Admiralty officer in charge of the mails. The *Amazon* was the first of the direct line of steamships arranged by the company to run fortnightly between Southampton and Chagres, touching only at St. Thomas, at which place various lines of branch packets for the accommodation of the West Indies, the Gulf of Mexico, &c., were to meet, diverging thence to the different islands and ports embraced in the new arrangements with Government, and thus establishing, as it was termed at the time, "a great steam ferry between Europe and the Isthmus of Panama."

In the course of the day after her departure, when steaming at the rate of about 9 miles an hour against a stiff south-west gale, the bearings of the paddle-shafts became so hot from the excessive friction of the new machinery, that on two occasions the engines had to be stopped to cool them, in one case for two and a half hours; after which everything appeared to be in order. But at midnight of the evening of the 4th January, when the *Amazon* was somewhere about 110 miles west-south-west of the Scilly Islands, the watch on deck, to their dismay, discovered that a fire had broken out suddenly on the starboard side forward between the steam-chest and that portion of the deck whereon the galley stood, the flames at once rushing up the gangway in front of the foremost funnel. So

sudden, indeed, was the conflagration that when the alarm bell, instantly sounded, brought the captain upon deck, it was only to witness the inevitable destruction of his ship; the force of the gale then blowing having spread the flames with such rapidity that every appliance, by means of wet swabs, buckets of water, and at last the fire pumps (for they had not been ready), proved alike utterly futile to check the progress of the fire.

The most terrible consternation and confusion now prevailed. Passengers and crew rushed on deck in the wildest dismay, while the gale which raged overhead increased their fears. To add if possible to the terrors of this awful calamity, the smoke and flames had driven the engineers from their stations, so that the machinery could not be stopped; consequently the *Amazon* dashed through the waves at full speed. Thus the raging fire, made more fearful by the storm, consumed everything animate and inanimate within its reach, spreading with the most alarming rapidity over the deck of the ship and extending to the cabins below, where many of the passengers were either suffocated by the smoke or consumed by the flames.

Recourse was now had to the boats: of these there were nine, including four life-boats. As too often happens in cases of emergency, the boats were neither clear nor ready for lowering. In this instance, too, the life-boats had been fitted with crutches on which their keels rested. These fittings now obstructed their clearance from the sides of the ship, and but for this fatal arrangement so serious a loss of life might have been lessened. To make matters worse,

the two best and largest boats had been stowed on the top of the sponsons, which were now surrounded by the flames and could not be approached. When the mail-boat was lowered, it was immediately swamped with twenty-five persons on board, all of whom perished; the pinnace, when lowered, sheered across the sea before the people in her could unhook the foretackle, and they too were all washed out and drowned, except two men who had clung to the thwarts and were enabled to scramble back to the deck of the ship: the boat itself, which hung by the single tackle, was soon afterwards dashed to pieces against the side of the vessel. By extraordinary efforts fourteen of the crew and two of the passengers were enabled to remove from the cranes and lower in safety one of the starboard lifeboats, while nineteen of the crew and six of her passengers escaped in another: these, with a young midshipman, named Vincent, who displayed great bravery and intrepidity, the chief steward, one passenger (a young lady), and two of the seamen, who had managed to lower without accident a small boat, the dingy, were the only persons saved out of the 161 who had embarked on board the *Amazon* only two days previously. All the others perished, including the captain, either by the flames or the waves; and, perhaps, in the melancholy annals of the sea, there is no shipwreck more appalling than that of the *Amazon*.

No writer of romance in the wildest dreams of fancy could have pictured a scene more terrible than this reality. Young Vincent, in his vivid narrative, describes two passengers rushing from **Terrible sufferings.**

their cabins enveloped in flames and falling lifeless upon deck. He speaks of a lady, with an infant in her arms, entreating some one to take care of her child, heedless of her own safety, but before assistance could be rendered perishing with her child amid the flames. Others, he says, fled from them, only to be engulfed in the ocean. One lady passenger, who had been lifted into the boat, was so terrified by the waves which dashed over the sides of the ship that she preferred death among the flames, and wildly rushed back to her destruction. Others fell through the burning decks or hatchways, and were instantly consumed, while some resigned themselves calmly to their terrible fate; when Vincent left the ship he states that "some of those who yet lived were kneeling on the deck in prayer, while others, almost in a state of nudity, were running about screaming with terror."

Between three and four o'clock in the morning the masts of the vessel fell over her sides; the foremast on the port and the mainmast on the starboard, but the mizen still stood while the fire raged from stem to stern. One poor fellow then appeared perched on the extreme end of the jib-boom, the only living thing amidst the burning mass; but he, too, perished. About five in the morning, when the life-boat was "passing the ship in a leewardly direction," the gunpowder in her magazines exploded, and in about twenty minutes afterwards, the mizenmast went by the board; the vessel herself then making a heavy lurch, as if eager to escape from the flames, went down, her funnels still standing, but red hot, with everything on board which the fire, in its fury, had left unconsumed.

The destruction of the *Amazon* following so quickly upon the stranding of the *Demerara* at Bristol (another of the five additional vessels which the company had just launched), materially inconvenienced the directors in the fresh arrangements they had made with Government for the more expeditious delivery of the mails. They had now only the *Oronoco*, *Magdalene*, and *Parana* to conduct the direct service between Southampton and the isthmus of Panama; but these misfortunes appear to have stimulated the shareholders to renewed exertions. Other vessels were engaged and fresh contracts entered into for the construction of steamers of a still finer description.[1] When, at length, Government relieved the company from the condition of building wooden vessels adapted for purposes of war, and the directors themselves discovered that iron was preferable to wood and the screw a better mode of propulsion than the paddle-wheel, they produced vessels equal to most of those now engaged in Transatlantic navigation. Of late years, their average of loss, until very recently, has been comparatively small. Loss of the *Demerara*

[1] The following is a return of the vessels which were added to the fleet of the Company between 1851 and 1860 inclusive:

	Number of Vessels.		Tonnage.		Horse-power.	
	1851.	1860.	1851.	1860.	1851.	1860.
Under 1,000 tons	5	4	2,949	2,838	1,030	900
1,000 to 1,500 „	Nil	2	—	2,371	—	680
1,500 to 2,000 „	9	6	16,593	11,057	3,900	2,510
2,000 to 3,000 „	1	6	2,069	14,683	440	4,120
Over 3,000 „	Nil	3	—	10,070	—	2,400
	15	21	21,611	41,019	5,370	10,610

Additions to their fleet,

There are not now many finer steamers afloat than their *Tagus* and *Moselle*, which were launched in the year 1871 from the yard of Messrs. John Elder and Co. The former, a vessel of 2789 tons builders' measurement and 600 horse-power, attained a mean speed of 14·878 knots per hour on the occasion of her official trial; while the *Moselle*, a sister ship, of about 3200 tons gross register, surpassed her, having made 14·929 knots per hour as the average of four runs over the measured mile. Equally satisfactory results have attended many of their other vessels, and not the least remarkable is the case of the *Tasmanian*, an iron screw-vessel they purchased from the unfortunate European and Australian Steam Navigation Company. This vessel, which was also fitted in 1871 by Messrs. John Elder and Co. with engines on the compound principle, accomplished her first voyage to St. Thomas in 338 hours (14 days, 2 hours) on a consumption of only 466 tons of coal, though she formerly consumed 1088 tons on a run of 349 hours (14 days, 13 hours).

and superior class of vessels.

An entire change of management combined with a superior class of vessels have had a very material effect on the prosperity of the company, enabling the directors at their last meeting to declare a dividend of 10 per cent. per annum. Their fleet[1] is now a large and excellent one, and well adapted, on the whole, for the due performances of the various mail services[2] undertaken by the company. It is further

[1] See Appendix No. 19, p. 634.

[2] These services from Southampton with mails, passengers, and cargo, are as follows:

2nd of each month—for West Indies, Cuba and Mexico, Colon (Aspinwall), Savanilla, Panama, Central America, South and North Pacific, San Francisco.

only just to the company, before closing this sketch of its operations, to record the services which it rendered to the British Government in placing some of its finest ships at the disposal of the naval department for the conveyance of troops during the Crimean War, more especially as the operation was carried out with only a trifling interruption to the contract mail service.

9th and 24th of each month—for Brazil and River Plate Routes, viz. Lisbon, St. Vincent (Cape de Verde), Pernambuco,[1] Bahia,[1] Rio de Janeiro, Monte Video, Buenos Ayres.

17th of each month—for West Indies, Belize, Grey Town, Colon (Aspinwall), Savanilla, Panama, Central America, South Pacific, Acapulco, Mazanillo, San Francisco, British Columbia, Japan, China.

An additional steamer also leaves Southampton the 10th of each month for Barbadoes, Trinidad, La Guayra, Porto Cabellos, Curaçoa, Santa Marta, Savanilla, and Colon.

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[1] The steamers of the 24th of each month do not call at Pernambuco or Bahia.

CHAPTER VIII.

Pacific Steam Navigation Company—First steamer on the Pacific, 1825—Mr. Wheelwright—Obtains a charter, 1840—First vessels, the *Chili* and *Peru*—Warm reception at Valparaiso—The Company persevere—Appointment of Mr. Just, 1846—Extension of contract, 1850—Marked improvement in the prospects of the Company, 1860—New lines—Vast increase of capital, 1867—Further increase of capital to 3,000,000*l.*, 1871—Capital increased to 4,000,000*l.*, 1872—Extent of fleet, *Iberia* and *Liguria*—*Chimborazo*, 1871—Too rapid increase—Loss arising therefrom—Modification of mail contract and reduced services—West coast steamer *Bolivia*—Future prospects of the Company—Trade with Mexico—First line of steamers from Liverpool to Chagres—West India and Pacific Steam Navigation Company—Liverpool, Brazil, and River Plate Steam Navigation Company.

Pacific Steam Navigation Company.

ABOUT the period when the West India Steam Line was in course of formation, another company, destined to surpass it in importance, had obtained from the British Government a charter for establishing "steam navigation along the shores of North and South America in the Pacific Ocean," as well as between those shores and China, the Australasian Colonies, and certain ports in the West Indies and in the Atlantic Ocean.

To establish a line of steam-ships for the purpose of carrying on efficiently the large and valuable, but hitherto undeveloped, commerce within the area named was indeed a bold undertaking, and one requiring extensive and varied knowledge, with a

large amount of experience and judicious management combined with the necessary amount of capital. These various requisites were not, however, readily obtained at a period when ocean steam navigation was comparatively in its infancy, and were rendered still more difficult by the knowledge that the endeavours of the original projectors of steam navigation on the shores of the Pacific had not been attended with success. Indeed, the first of those undertakings proved most unfortunate, and was, also, accompanied by a good deal of romance.

First steamer in the Pacific, 1825.

So early as 1825, when the struggles among the republics of the South Pacific for supremacy were at their height, a few merchants resident in Panama formed themselves into an association for the purpose of trading along those shores, but they had so many difficulties to overcome that a long time elapsed ere they could obtain the required capital. The first steamer on the Pacific coast was a small craft named the *Telica*, commanded and owned by a Spaniard named Mitrovitch; but his career and that of the vessel under his charge was a short and melancholy one. In a fit of despair at his want of success, with some further annoyance from the complaints by his passengers, caused chiefly by delay, and his inability to find a sufficient supply of fuel, he fired his pistol into a barrel of gunpowder, blowing up his vessel in the harbour of Guayaquil, and destroying himself and all on board except one man. An occurrence of this lamentable nature, though it happened ten or fifteen years previously, would, in most cases, have destroyed, for many years subsequently, any attempts, by means of steamers, to trade between Valparaiso

and Panama, had not a gentleman, then resident in Guayaquil and familiar with the trade of the coast, taken up the business with the determination to carry it through at all hazards.

Mr. Wheelwright.

William Wheelwright,[1] an American citizen, and at that time United States' Consul in Guayaquil, was no common man. He saw the advantages to be derived from developing the rich resources of the eastern shores of the Pacific, and the facilities which steam communication would afford to the more frequent and more rapid intercourse between the then rival republics. Nor was he mistaken in the views he entertained, though he had many difficulties to overcome. Steam, while it eventually became the chief means of settling the petty wars which had so long raged, offered, at the same time, so many new sources of profitable employment, with the opening up so many new channels of trade, as happily to direct the atten-

[1] Mr. Wheelwright was born at Newburyport, Massachusetts, U.S., in 1798, where his ancestors from Bilsby, in Lincolnshire, had settled so early as the year 1629. His first visit to South America was in command of one of his father's vessels, where he was wrecked at Cape Corrientes in 1821. In the following year, he sailed as supercargo in a vessel to Valparaiso and thence proceeded viâ Peru to Guayaquil, where he established himself as a commission merchant and was, in 1824, appointed United States' Consul. Having frequent occasion to make voyages along the Pacific coast, he saw the advantages to be derived from steam communication, which subsequently led to the formation of the Pacific Steam Navigation Co. His intimate connection with that company, as one of its most active managers and directors, continued until 1855, when he directed his attention more especially to the construction of railways in South America, his first line between Caldera and Copiago proving so great a success that "in a few years the dividends paid to its shareholders amounted to double the entire cost." Subsequently, he, in association with Messrs. Brassey and Wythes, constructed the line between Cordoba and Rosario, which was opened in 1870, when the President, addressing him, said, "The Argentine Republic have not wherewith to acknowledge the greatness of your works." Mr. Wheelwright died in London, 16th September, 1873.

tion of the native inhabitants from the struggles of war to the peaceful pursuits of commerce. Studying the wants of those countries and the most efficient means of affording profitable employment to the people, Mr. Wheelwright spent six of the best years of his life in arranging plans for steam communication between the different republics, and, at last, obtained from the Peruvian, Bolivian, and Chilian Governments the privilege of thus navigating their coasts for the term of ten years. He then made a journey to England for the purpose of endeavouring to influence the wealthy merchants of this country to aid him in the undertaking.

Here, however, he had still many difficulties to overcome, for the trade he proposed to develop was then comparatively unknown, and the little wars between the republics of the Pacific naturally led English merchants to hesitate, ere they embarked their capital in a company whose prospects were at that time far from encouraging. Nevertheless, he succeeded in his object, and, on the 17th of February, 1840, obtained, under letters patent, a charter for the establishment of the undertaking now known as the Pacific Steam Navigation Company, together with a small subsidy for the conveyance of the mails.

Obtains a charter, 1840.

This contract differs from all others, in this respect, that the vessels employed under it do not touch at any port of Her Majesty's dominions, although, practically, it may be considered as providing a continuation of the line from Southampton. The extension of British influence and British commerce was, doubtless, the chief inducement for supporting this

communication between the republics of New Grenada, Bolivia, Peru, and Chili; the nature and extent of that traffic rendering it necessary for the English to maintain mercantile establishments in the chief ports and towns on the western coast of the Pacific, and thus justifying Government in incurring this expense.[1]

The capital of the Pacific Company at first was limited to 250,000*l.* in 5000 shares of 50*l.* each. Though the whole capital, after a good deal of labour, was subscribed, only an amount was called up sufficient at the time to enable the directors to provide two boats, the *Chili* and the *Peru*, which were dispatched to commence operations towards the close of the year 1840.

First vessels, the *Chili* and *Peru.*

These vessels were built of wood by Messrs. Charles Young and Co. of Limehouse, London. They were sister ships, each of about 700 tons gross register, though with a capacity of not half of that tonnage, and with engines of about 150 horse-power constructed by Messrs. Miller and Ravenhill. Through the courtesy of the directors, I am enabled to furnish the following illustration of the *Peru*, whose dimensions were 198 feet extreme length and 50 feet

[1] "A broader and more promising field for steam operations than that which the Pacific affords, does not exist in any part of the world. The prevailing south winds, the calms, and the currents of that ocean render navigation by sailing-vessels tedious and uncertain in the extreme; while the nature of the whole country, from Valparaiso to Guayaquil—presenting a succession of mountains and deep ravines, intersected by sandy deserts—offers every imaginable obstacle to land travelling; and, yet, there are four millions of inhabitants within the proposed line of intercourse ready to participate, to a greater or less degree, in the benefits to arise from the proposed undertaking."—Pamphlet on 'Steam Navigation in the Pacific,' by Mr. Wheelwright: London, 1838.

extreme breadth. They were at that time considered fine vessels and certainly they have a comfortable business-like appearance. No wonder, therefore, that, on their arrival at Valparaiso, they were received with great rejoicing and with "salvoes of artillery, everybody wishing to visit them, the President of the Republic, accompanied by his

Warm reception at Valparaiso.

"PERU."

ministers, being among the first to welcome the steam-ships to the shores of the Pacific."

But here again, Mr. Wheelwright had many difficulties to overcome, the scarcity of fuel, as in the case of the *Telica*, being one of the greatest. Under these circumstances, the Company, during the first five years of its operations, sustained a loss of no less than 72,000*l.* upon a paid-up capital of 94,000*l.* In the face, however, of these heavy losses, the

shareholders resolved to persevere with their bold undertaking, seeing in it the germs of future success. Under the impression that the business of the Company could be better conducted in Liverpool, where most of the shareholders resided, the directors, on the 4th May, 1846, obtained a supplemental charter to remove from London to that city, where the head office and general management, have since been conducted by Mr. William Just, who, in January of the following year, was appointed its managing director. In December 1847, the directors were enabled to give to the shareholders for the first time a dividend, though only 2½ per cent., on their paid-up capital.

The Company persevere.

Appointment of Mr. Just, 1846.

In 1850, the Company obtained an extension of its mail contract of 1845–46, whereby the directors were required to provide not less than six steamers, of at least 170 horse-power each, but, at the suggestion of the Company, the Government, in November of that year, allowed four steamers of 1000 tons and 300 horse-power to be substituted for the six smaller vessels originally contemplated.[1]

Extension of contract, 1850.

The prospects of the undertaking were, however, still far from encouraging, and when, in February 1853, the directors represented to the Board of Admiralty that the expense arising from the greatly increased price of coals rendered the portion of their service between Callao and Panama altogether unremunerative, and asked for an increase of subsidy, they were refused. The directors then solicited permission to employ between these two places vessels

[1] The four steamers supplied (at a cost of 140,000*l.*), in pursuance of the company's contract with the Admiralty, were the *Lima*, *Santiago*, *Quito*, and *Bogota*: they were to be employed in the bi-monthly service between Valparaiso and Panama.

of only 100 horse-power and 400 tons, which they considered would be sufficiently large for the passenger traffic, and would restore the balance of profit by reducing the cost of fuel. They also undertook that these vessels should be capable of maintaining an average speed of 10 knots an hour, and that the mail service should not suffer. This proposal Government acquiesced in, temporarily, reserving to itself the right of reverting to the original agreement.

The more frequent and more speedy services had, indeed, become, if not necessary, at least desirable, since the West India Mail Packet Co. had doubled the services of their ships between England and Colon. The Pacific Co. therefore felt that, if they did not run their vessels to and from Panama in connection with the steamers from England, those of the United States of Amercia, now rapidly increasing in the trade of the Pacific, might soon monopolize the lines they occupied from the Isthmus to the southern ports. Consequently, the directors of the Pacific Company were glad to accede to the proposal of the Admiralty to run steamers with the mails monthly from Panama, for the small increase of 5000*l.* per annum to their original contract of 20,000*l.*

This Company had now in its service seven vessels of 5719 tons and of 2396 horse-power; but, though they touched at no less than thirteen ports between Panama and Valparaiso inclusive, the average annual amount of receipts for postage, for five years previously to 1860, amounted to only 5441*l.*

In 1856, Mr. Just visited the west coast, and re-organized the management and the service generally with very successful results. Towards that success

his adoption of the compound engine,[1] then almost a novelty, materially tended, effecting as it did, an enormous saving in the consumption of fuel and, consequently, in the current expenses of the Company.

Marked improvement in the prospects of the Company, 1860.

From 1860, the trade of the Pacific rapidly developed itself. The inhabitants of the coast now saw the incalculable advantages to be derived from regular and increased intercourse between other countries. Steam here, as it has done everywhere else, opened up new and hitherto unthought of branches of commerce; the natives learned what other nations required, and, to meet these demands, they turned to cultivating their fields instead of fighting among themselves. Consequently, the Pacific Company soon found it necessary to increase the number of their fleet. In December 1859, a second supplemental charter was obtained, which extended the incorporation of the Company for twenty-one years from the 17th of February, 1861. On the 15th of June,

New lines.

1865, a third supplemental charter was applied for and obtained, extending the powers of the Company, to the establishment of lines of communication "between the west coast of South America and the River Plata, including the Falkland Islands and such other ports or places in North and South America, and other foreign ports, as to the said Company shall seem expedient."

[1] The directors of the Pacific Co. by degrees applied the compound engine after 1856 to all their steam-ships, and it is worthy of record that they were not only among the first, if not the first, to adopt the compound engine for ocean-going steamers, but were almost singular in this respect for upwards of fourteen years. This description of engine has now entirely superseded all others for the purposes of steam navigation.

During these years the profits of the undertaking had been steadily increasing, and at a special meeting of shareholders held in December 1867 it was determined to add to the operations of the company by establishing a monthly line *from Liverpool* to the west coast of South America, *viâ* the Straits of Magellan. **Vast increase of capital, 1867.**

This entirely new and important, though hazardous, branch of the service necessitated an increase of the capital of the company to 2,000,000*l.* In furtherance of their views the directors sent their steamer *Pacific*, of 2000 tons register and 450 horse-power, from Valparaiso, in May 1868, as the pioneer of the new mail line.

The bold undertaking of dispatching steamers on so distant a voyage, and at so high a rate of speed as that maintained, proved for some years more successful than could have been anticipated, and, in 1869, the profits of the four new steamers, which had made nine voyages from Liverpool to Valparaiso, were so satisfactory that the directors in 1870 determined to make the line bi-monthly, and extend the voyage from Valparaiso to Callao. Seventeen voyages made in the course of that year with still greater success, induced the directors to recommend that the departures thenceforward should be three a month; and, in December 1871, the shareholders authorized a further increase of the capital to 3,000,000*l.*, so that the company might be enabled to dispatch every week one of their steamers on this distant voyage. **Further increase of capital to 3,000,000*l.* 1871.**

Considering the then comparatively limited amount of the trade it was a very bold experiment. While

directors of undertakings of this nature very properly consider it their duty to meet and even to anticipate the requirements of the public, so as to prevent others occupying their field of operations, and thus avoiding injury from competition, it may well be questioned if this extraordinary increase of steamers could be justified by any reasonable anticipations of the increase of the trade to be developed by these additional facilities, and within so limited a space of time. The result, indeed, soon showed that they were now too far in advance of the requirements of commerce. Though, in 1871, twenty-nine round voyages were performed between Liverpool, Valparaiso, and Callao, the profits, so far from being increased, gave signs of falling off; and, in 1872, thirty-seven round voyages were made with, as the result proved, a further diminished rate of profit, the directors having, in January of that year, recommended at a special meeting of shareholders the addition to their fleet of four more steamers at a cost of 500,000*l.*

Capital increased to 4,000,000*l.* 1872.

In the course of the following July, a further charter had been obtained authorizing an additional 1,000,000*l.* of capital to be raised, and thus, with power to draw on the shareholders to the extent of 4,000,000*l.*, the whole capital of the company, the directors did not hesitate to still further increase their already gigantic fleet!

Extent of fleet.

The company now owns no less than fifty-four steamers, of an aggregate of 119,870 tons, and 21,395 horse-power.[1] Two of these, the *Iberia* and

Iberia and *Liguria.*

Liguria, built and supplied with engines by Messrs.

[1] See Appendix No. 20, pp. 635–6.

John Elder and Co., of Glasgow, in 1873, are each 4671 tons gross register with a capacity for 4000 tons of cargo, besides space for 916 tons of coals, and accommodation for no less than 800 third-class passengers. They are each of 700 horse-power nominal, and attained a speed on their trial trips of 15 knots per hour.[1]

But, though inferior in power and dimensions, the vessels the company had built previously to this time for their Liverpool and Valparaiso line were equal in other respects to the new ones. Indeed, as may be seen by the following representation of the *Chimbo-* *Chimborazo*, 1871.

" CHIMBORAZO."

razo, launched in 1871, also from the yard of Elder and

[1] The length of these steamers is 425 feet between perpendiculars and 449 feet over all. Their breadth is 44½ feet, and their depth of hold 35½ feet. The engines, which are compound, have each three cylinders, one of 4 feet 8 inches diameter and two of 6 feet 6 inches diameter, with 5 feet length of stroke.

Company, they were not surpassed by any steamers afloat. She is a sister ship of the *Cuzco*, built by the same firm, as also of the *Garonne* built by Robert Napier and Sons and launched the same year. They are each 370 feet in length between perpendiculars, 41 feet beam, 35 feet depth of hold, and about 3850 tons gross register tonnage. They perform their passages on the coast with remarkable speed and regularity, while the voyage from Liverpool to Valparaiso is usually made in forty-two days. But, for the time being, the company has found itself overtaken by severe competition and depression in the west coast trade, and has been obliged to reduce the services on the line from Liverpool to that coast to two voyages each month instead of one weekly; in consequence of which nine of their steamers are, at present, laid up for want of employment.

Too rapid increase.

Loss arising therefrom.

Although the loss thus sustained may be attributed in no small degree to the over-sanguine views of the directors in regard to the development of the trade between Great Britain and the west coast of South America, some portion of it is also due to the competition on the coast and to the opposition they met in performing the weekly service for which they had obtained a postal contract from Her Majesty's Government in December 1872. Bound to a speed in excess of what had been required of other companies, and with a grant of only the sea postage, it was impossible for them to hope to compete successfully with such highly subsidized companies as the Royal Mail and the French Messageries Maritimes, both of which maintain an opposition race to those ports of the Brazils whence the Pacific Steam

Navigation Company hoped to derive some advantage by the conveyance of passengers on their way to Valparaiso.

Indeed, where a high rate of speed is required, and where heavy penalties are inflicted for any irregularity in the performance of the stipulated service, it is very questionable, unless when highly subsidized, if any advantage whatever is to be gained by the conveyance of mails on so distant a voyage as that which the Pacific Company had undertaken to perform. But, by reducing the number of services and modifying the rate of speed, which the Government at last consented they should do—requiring, however, a reduction in the amount of subsidy—the directors, on the one hand, may hope to secure a sufficient amount of remunerative freight; and, on the other, to effect a saving in the consumption of coal—a matter of the highest consideration on such distant voyages.

Modification of mail contract and reduced services.

Although the anticipations of the directors, in the more recent and expensive portion of their great undertaking, have not been realised, while the services of the steamers on the West Coast have periodically, and especially of late, been subjected to considerable depression, the trade of the Pacific has steadily and, compared with any previous development, marvellously increased since first opened out by the energy of Mr. Wheelwright. Moreover, this trade is likely to go on increasing, especially as the company has now a class of vessels admirably adapted for its still increasing wants, and affording many comforts to passengers who, induced by nume-

rous attractions travel either for business or pleasure, along the shores of the Pacific.

West Coast steamer, *Bolivia.*

The following is an illustration of one of the steamers now engaged on the Pacific coast line; but the *Santa Rosa* and the many similar vessels belonging to the Pacific Company now trading along these shores,[1] have been greatly surpassed by their screw-steamer *Bolivia*, of 1925 tons, launched from the building yard of Messrs. T. Wingate & Co., Glasgow, in 1874, and which is perhaps the finest,

"SANTA-ROSA."

or at least, one of the finest vessels now afloat on the Pacific. The details of this handsome ship, which has an average speed of 14 knots an hour, as have also those of the other vessels of the company, will be found in the Appendix, together with interesting and instructive returns of the cost of each ship complete for sea.[2]

Future prospects of the company.

With the losses this company have sustained

[1] The *Santa Rosa* is 320 feet in length, 38 feet in breadth, and 28 feet deep to the main deck on which a range of cabins extend for nearly the whole length, as may be seen from the drawing, affording the perfect system of ventilation so much required in steamers employed in tropical climates. She is 1816 tons gross register, and is propelled by a screw, although some others of smaller class still use the paddle-wheels.

[2] Appendix No. 20, p. 637.

during the last few years, the differences between the shareholders and directors, and the charges of mismanagement and extravagance which have been alleged, it is not my province to deal. Companies and nations, like individuals, are frequently too prone to spend more than they ought, if unusual success has attended their efforts, or they find more money at their disposal than they can prudently or wisely expend. It has been so throughout all time and in all countries, and we daily see it in the case of individuals managing their own affairs.

It is, therefore, not surprising, and certainly nothing new to learn that, when the directors of the Pacific Steam Navigation Company were favoured with many years of unusual prosperity, after many years of hard up-hill work, and were able to divide an average of over 20 per cent. per annum among their shareholders, they should have followed the example of individuals, of companies, and of nations throughout all history; and that, in the sanguine hope of being able to maintain this prosperity, they should have expended money in the construction of ships not required, and for, perhaps, even less justifiable purposes.

It should, however, be remembered, of this great undertaking when its failings are noticed, that it has rendered very important services in developing British commerce and that, in bringing so many civilizing influences to bear upon the people of various republics, who, from their constant warfare with each other, were little better than tribes of semi-barbarians, the Pacific Company has essentially aided the cause of progress and the happiness of mankind.

These advantages will be felt long after its mishaps are forgotten.

The field which the directors have chosen for their operations, is still only very partially developed, and there is, consequently, a great future for this company, if wisely and prudently conducted. It requires no prophetic vision to see that, as the commerce of the world moves westward, the principal highway to the ever envied and far famed East will be by the route which Columbus sought in vain across the Pacific Ocean. Indeed, San Francisco will soon be a greater entrepôt for trade than ever Venice was, and may, even before long, rival in many respects the now gigantic commerce of Great Britain.

Trade with Mexico. The steady increase of trade along the whole of the western shores of the Pacific has already rendered necessary greatly increased means of intercourse with Europe and the United States of America, which the line of railway across the Isthmus has assisted to develop with extraordinary rapidity. Other channels of trade in that quarter have likewise been recently opened, rich in themselves and capable of vast extension, through the medium of steam.

Although many schemes had been set on foot during the last three centuries, for re-opening the commerce of Central America, and, especially, of that portion of it which has its outlet into the Gulf of Mexico and the Caribbean Sea,—among these none being so conspicuous as the unfortunate Darien expedition—all attempts proved abortive until the latter half of the present century. Indeed, till the completion of the

railway, none of these were worthy of any notice. So rapid, however, has been its increase since then, that the undertakings of more recent years have been attended with considerable success. Perhaps the most important of these is the line of steam navigation between Liverpool and the West Indies, and, thence, by the Isthmus of Panama, to the Pacific Ocean, originally due to Mr. Alfred Holt, of Liverpool, who about the year 1855, dispatched steamers to trade between that port and Colon (the Atlantic terminus of the Panama Railroad) and other ports on the Spanish Main. His first was a vessel of only 535 tons burden, but she was then more than sufficient for any surplus commerce, which the American boats, on the one hand and those of the West India Mail Packet Co., on the other, could not convey. The regularity, however, with which this additional service was performed, created increased sources of employment, so that within a very short time, Mr. Holt considered it desirable to establish a monthly line of steamers of increased size and power, and so rapid was the rise of trade that other steam-vessels were soon engaged in similar traffic. In 1863, Messrs Leach, Harrison, and Forwood of Liverpool, large importers of produce from the West Coast, found it necessary to establish a line of steamers in a great measure for their own requirements, and about the same time, Messrs Imrie and Tomlinson, in association with Messrs Duranty and Co., of Liverpool, who had long been engaged in the trade with Mexico and the West Indies, formed another line of steamers on the limited liability principle. The trade in its various ramifications had now become so large that, towards the close of that year,

First line of steamers from Liverpool to Chagres.

it was considered desirable to form a public company to amalgamate these three undertakings, and thus more thoroughly to conduct the rapidly increasing commercial intercourse between Liverpool, Mexico, Honduras, Venezuela, and the Windward Islands.

West India and Pacific Steam Navigation Company.

The capital of 1,250,000*l.* was at once subscribed, and this new undertaking now known as the West India and Pacific Steam Navigation Company (Limited), finding it necessary to re-organize the whole business and, in addition, to embrace the Colon trade, and other lines of traffic, subdivided the services into five separate branches—one to Belize, one to Tampico, one to Colon, one to St. Thomas, and one to Trinidad.[1] It was also arranged to dispatch steamers to Barbadoes and Demerara. The trunk or principal line of the company is that to Colon, in connection with the Panama railroad, and, by it, with the various steam lines on the Pacific, the company signing through bills of lading for no fewer than seventy ports, at sixteen of which their vessels call to land goods and passengers.

This undertaking, which has met with considerable success, conveys the British mails to Honduras and Mexico. It now owns thirteen steamers of 24,680 tons gross register. Though inferior in size and power to the steam-ships of the other Transatlantic lines, they are a very fine class of iron screw propelled vessels, maintaining an average speed of more than 10 knots an hour, and performing the passage with great regularity from Liverpool to St. Thomas in eighteen, and to Colon in about twenty-two days.

[1] "Steam Lines of Liverpool," page 37.

Besides those I have mentioned, various other lines of steam-ships now traverse the Atlantic north and south, as well as casual steamers and large numbers of sailing-vessels, most of the former being the property of associations carrying on business, either under the old law or under the Limited Liability Act.

Liverpool, Brazil, and River Plate Steam Company.

Among the largest of these may be mentioned the Liverpool, Brazil, and River Plate Steam-ship Company (Limited), which was formed in 1865, the principal shareholders being Messrs. Lamport and Holt, of Liverpool, by whom the steamers are managed, and a few of their personal friends. There is nothing, however, in their fleet of vessels requiring special notice, except that they are a very fine class of business steamers and have performed their work with great regularity. They are now thirty-one in number, of a gross tonnage of 49,294 tons,[1] and have excellent accommodation, combined with every comfort which passengers can desire, offering all the means of safety in their prudent management, and regularity of system, which can be hoped for in Transatlantic voyages.

Although the vessels of this company are principally engaged out of Liverpool, some of them sail from London and Antwerp, calling frequently at Havre and Lisbon in the course of their trade with the ports of Brazil and River Plate, Pernambuco, and Buenos Ayres. One of them proceeds monthly, up the River Parana to Rosario, and, occasionally, others return from Brazil to the United States with cargoes of coffee. Three are permanently engaged in the service of the Government of Brazil for the

[1] See Appendix No. 21, p. 637.

conveyance of mails between Rio de Janeiro and the southern ports, while others maintain a direct line of communication with Brazil and Antwerp. The Company is also under contract with the British Government to dispatch, on the 20th of each month, a steamer with the mails from Liverpool to Bahia, Rio Janeiro, Monte Video, and Buenos Ayres, returning with a monthly mail from each of these ports. Steamers are likewise dispatched on the 3rd, 10th, and 12th of each month to the other ports, with extra vessels at such dates as the requirements of the trade may demand. The last new steamer, the *Herelius*, of 2610 tons register, was built by Messrs. Andrew Leslie and Company, Hebburn-on-Tyne, and her engines, of 300 horse-power nominal, are by Messrs. Robert Stephenson and Co., Newcastle; she is an excellent specimen of a merchant-steamer, being 345 feet in length, 37 feet in breadth, and 27 feet depth of hold from maindeck, with a large capacity for cargo, and a speed on the measured or trial mile of from 11 to 12 knots an hour, on a moderate consumption of fuel.

Though, by an ancient Act of Parliament, the responsibility of shipowners has been limited—no doubt for the purpose of encouraging navigation—to the value of the ship and freight, numerous companies of shipowners have been formed, under the Limited Liability Act of 1862, consisting of a few individuals, as in the case of Messrs. Lamport and Holt's line, for the purpose of conducting different branches of maritime commerce. Many of these are larger and more important undertakings than the great bulk of the public steam navigation companies,

and have generally proved more successful from the fact that their managing directors usually hold themselves a very large amount of capital invested in them. To some of these I shall have occasion to refer hereafter. In the meantime, I must invite the attention of my readers to the trade with the East, as now conducted by steam-vessels.

CHAPTER IX.

Steam to India and overland routes—East India Company establish a Tâtar post between Constantinople and Baghdad—First public meeting in London to promote steam communication with India, 1822—Captain Johnston—Calcutta meetings, 1823—The *Enterprize*, first steamer to India by Cape, 1825—Sold in Calcutta to East India Company—Other steamers follow—Pioneers of overland route viâ Egypt—Sir Miles Nightingall in 1819 and Mount-Stuart Elphinstone in 1823 return home by this route—Mr. Thomas Waghorn visits England to promote the Cape route, 1829-30—Returns to India by way of Trieste and the Red Sea—Still advocates Cape route, 1830—Mr. Taylor's proposal—Reply of Bombay Government and discussion of the question—Supineness of the Court of Directors—Their views—Official report of the first voyage of the *Hugh Lindsay*, 1830—Report of the Committee of 1834—Decision of the House of Commons Committee influenced by political considerations—Admiralty packets extended from Malta to Alexandria—Steamers of the Indian navy—Modes of transport across the Isthmus of Suez—Great exertions of Waghorn in the establishment of this route—Suez Canal—Popular errors on this subject—M. de Lesseps—His great scheme—Not fairly considered in England—Commencement of M. de Lesseps' works in 1857—General details—Partial opening of Canal, April 18th, 1869—Finally opened by Empress Eugénie, November 17th, 1869.

Steam to India, and overland routes.

HAVING in the early portions of this work endeavoured to trace the various commercial routes to the East by land and sea in the most remote periods as well as in the Middle Ages, I now invite my readers to accompany me while I attempt to furnish an outline of the modes by which commercial intercourse is

maintained with India and China at the present time, and of the transport service employed in conveying this commerce.

Although nearly the whole of the European trade with the East has, since the time of Vasco de Gama, been conducted by sea round the Cape of Good Hope, caravans through Arabia and Asia Minor and along the shores of the Red Sea, as well as by the more frequented route of the valley of Mesopotamia and the River Euphrates to the Persian Gulf, have never, since the days of Herodotus, altogether ceased. Indeed, during the reign of Elizabeth, and for sometime afterwards, many English merchants preferred the Euphrates route to the sea voyage, the course they then adopted, being apparently through Syria or Asia Minor to Bir, where a fleet of boats or barges, resembling those described by the Father of History, was at all seasons ready to convey them and their merchandise down the Euphrates to Hillah, near the site of Ancient Babylon, or by Mosul to Baghdad, the chief Eastern centre of commerce during the early part of the Middle Ages. From Baghdad their course was down the Tigris to Bussorah, where they embarked in native sailing-vessels for various parts of India.

East India Company establish a Tátar post between Constantinople and Baghdad.

An overland route between Europe and India had thus from time immemorial been sustained; and, though there was no established service between England and the East until a comparatively recent period, the East India Company, from the time they first became possessors of land in India, frequently sent despatches by the way of the Persian Gulf, thus creating at length a regular monthly commu-

nication between Constantinople and Baghdad, by Tátars, maintained at the cost of the Indian Government. Thus, at last, private letters as well as official despatches, were transmitted by these means, while, on important occasions, special despatches were forwarded by the same route at other than the monthly periods. This, so far as the East India Company was concerned, was the original, and the only official overland line of communication; and so it continued to be till it was superseded by the route through Egypt. Another generation may see it resumed by an iron highway.[1]

First public meeting in London to promote steam communication with India, 1822.

It was not, however, until steam-vessels began to attract attention that any regular postal service other than by sailing-vessels was seriously considered.

[1] Various plans for reaching India by means of railway communication throughout have been proposed. So early as 1850, Sir R. Macdonald Stephenson brought this matter fully under the notice of the Government. In the *Calcutta Review* for March 1856 his views are given at length; and his article therein, "The World's Highway," was republished in the same year by Weale. In 1859, the same publisher brought out a pamphlet by Sir Macdonald, entitled "Railways in Turkey, &c.," with beautifully executed plans (the most complete yet in existence) showing the course of these lines from Constantinople to Aleppo, Baghdad and Bussorah, thence along the shores of the Persian Gulf to Bunder Abbas, and thence to Kurachi, Hydrabad, in Scinde and Bombay. Sir R. Stephenson estimated the distance from London to Bombay viâ Paris, Vienna, and Constantinople at somewhere about 5200 miles. He bestowed many years' labour on this important subject; and had hoped to make it a great international highway, constructed under the supervision of the different states interested. Though unable to overcome the difficulties such a combination would entail, the works he proposed, or others somewhat similar, are being rapidly carried into execution by different persons who have obtained concessions from the respective Governments; more than 2000 miles of the World's Highway is already made, and when complete the journey from London to Bombay by rail would, at the rate of 30 miles an hour, be accomplished in less than seven and a half days. See also plan of route by Mr. R. H. Galloway, published by Wyld, 1875, in which the distances are given.

But on this subject opinions differed widely, the prevailing one at that time being at first in favour of the Cape route, transferring the conveyance of the mails from the old East Indiamen to steamers. Nothing, however, was definitely proposed till 1822, when a public meeting was held in London with the view of forming a Steam Navigation Company to trade with India, the result of which was the despatch of Lieutenant (afterwards Captain) J. Johnston, to Calcutta to see what could be done to prosecute the object in view. Johnston went through Egypt and became subsequently one of the ardent supporters of the route by Suez, though his own employment and the intention of those for whom he then acted, was more especially the promotion of the Cape route.

Captain Johnston.

Soon after his arrival in Calcutta, several meetings took place, the most important of which was held in the Town Hall of that city, December 17th, 1823,[1] with Mr. Harrington in the Chair. Various routes were then considered. At the meeting it was announced that the proposal of a more speedy communication with England by means of steam-vessels had met with the cordial approval of Lord Amherst in Council, who was prepared to recommend towards the promotion of the enterprise a "gift of 20,000 rupees" by way of premium "to whoever, whether individuals or a company, being *British* subjects, should permanently, before the end of 1826, establish a steam communication between England and India, either by the Cape of Good Hope or Red Sea, and make two voyages out and two home, occupying not more

Calcutta meetings. 1823.

[1] Full details of this meeting will be found in the *Bengal Hurkara*, December 19th, 1823.

S.S. "ENTERPRISE."

than seventy days on each passage." For this object somewhere about 80,000 rupees were raised in India, of which 12,000 were subscribed by the Rajah of Oude; and, on the news reaching England, another meeting was held in London, at which more money was collected, sufficient on the whole to justify the promoters to order as an experiment, the construction of the *Enterprize*, the first steamer destined to double the Cape of Good Hope.

The *Enterprize*, first Steamer to India, by Cape, 1825.

Captain Johnston having completed the object for which he had been despatched to India, returned to England in the *Eliza* by way of the Cape, and, on his arrival in London, the *Enterprize*,[1] which had been laid down in the yard of Gordon and Co., Deptford, was two-thirds finished. On her completion she was placed under his command, and sailed for Calcutta on the 16th of August, 1825, where she arrived on the 7th December following. Although 113 days on the passage, she was only 103 days under way, as ten were spent in stoppages to replenish her stock of coal; but her greatest average speed, during any twenty-four hours, not exceeding 9·36 miles per hour, accounted for by the large quantity of coals she was obliged to carry,[2] disappointed the expectations of the seventeen passengers who had embarked in her. (An illustration of this vessel is furnished on p. 340.)

[1] The dimensions of the *Enterprize* were 122 feet length of keel and 27 feet breadth of beam; her paddle-wheels were 15 feet in diameter. She was 479 tons register, 120 horse-power. She was supplied with a *copper* boiler in one piece, weighing 32 tons and costing 7000*l*. Her total cost was no less than 43,000*l*.!

[2] The greatest run the *Enterprize* made by sail in twenty-four hours, was 211 miles, the least 39 miles; the greatest by steam assisted by sail, 225 miles, the least 80 miles; the greatest heat in the engine-

The voyage of the *Enterprize*, ought to have convinced the advocates of the ocean route that it was not advisable, commercially, to persevere in such an undertaking, moreover, though this steamer was admittedly unsuited for so distant a voyage, other considerations, especially at that early period of steam navigation, made it doubtful whether vessels thus propelled, and by a route so long as that round the Cape, could yield remunerative returns. However, the *Enterprize*, though she did not receive the 20,000 rupees premium, was sold when she arrived at Calcutta, to the Indian Government for 40,000*l.*, who then required every ship they could get for the first Burmese war. She was at once appropriated by the East India Company, who employed her in carrying despatches from Calcutta to Rangoon, a service in which she proved of great value in aiding the operations of that campaign.

Sold in Calcutta to East India Company.

Other steamers follow.

The success thus far of the *Enterprize* encouraged the introduction of steam-vessels into the local trade of India; the comparatively narrow seas, excellent harbours, and safe inlets, as well as the many large and important navigable rivers of that part of Asia affording almost as large and remunerative fields for the employment of such vessels as the coasts, rivers, and lakes of North America. To this branch of commerce I shall hereafter refer. In the meantime

room during the voyage, was 105 degrees, that of the air at the same time being 84 degrees and a half; the total distance was 13,700 miles, and the consumption 580 chaldron of coals, being 9 chaldrons per day for 64 days, the rest being under sail; "the speed of the engines, in calm weather, was 8 knots an hour, the log giving 9 from the wash of the paddles." Evidence, Mr. T. L. Peacock, Select Committee on Steam Navigation to India, 1834.

I must ask my readers to accompany me in an attempt to trace the means of more rapid communication between Great Britain and her vast dominions in the East, with some notice of the persons to whom we are indebted for the advantages we have thus derived.

Pioneers of overland route, viâ Egypt.

As in other important changes and inventions, I find in my researches many claimants for originality; and though it may appear scarcely necessary to wade through the mass of papers[1] published by persons claiming for themselves or their friends the merit of an overland route which has existed since the dawn of history, I shall endeavour to furnish within a brief space the leading facts relating to the routes which, in our own time, have produced such marked changes in our commercial intercourse with India.

Though not so much frequented as that by the Euphrates route, travellers have found their way from time immemorial between Europe and India through Egypt, availing themselves of native vessels

[1] Despatches of Sir Miles Nightingall, 1819; Mount-Stuart Elphinstone, 1823–26; Lord William Bentinck, 1828 to 1835; "Annual Register;" Colonel Chesney's Report, 1832; Proceedings of the Royal Asiatic Society; Captain F. Head's "Eastern and Egyptian Scenery," 1833; J. A. St. John, "Egypt and Muhammed Ali," 1833; Report of the Committee of the House of Commons "On Steam Navigation to India," 1834; "Egypt in 1837," by T. Waghorn; Ibid. 1838; Waghorn and Co., "Overland Route to India," 1844 and 1846; "On Steam Navigation to India," by Captain Grindlay, 1837; Report of the Committee of House of Commons "On Steam Navigation to India," 1837; Mr. W. D. Holmes' plan in connection with the Bengal Steam Committee, 1839; "Modern Egyptians," by Sir Gardner Wilkinson, 1843; "Facts connected with the Origin and Progress of Steam Communication between India and England," by J. H. Wilson, Commander, Indian Navy, London, 1850; Letter from Mr. R. W. Crawford, M.P. for London, to the *Times*, November 22nd, 1869; and from Mr. R. H. Galloway to the *Illustrated London News*, 23rd October, 1872, as well as other communications on the same subject to various journals and periodicals.

for the Red Sea or along its coasts to the once far-famed lands of Yemen and thence to the ever coveted "Cathay" of the East. The first authentic record, in recent times, however, of any journey from India to Great Britain by the Isthmus of Suez, with the object of ascertaining whether that route could be renewed as a pathway of commerce, or, if not, for the transmission of despatches, was a passage made in 1819, by Sir Miles Nightingall, then Commander-in-chief of the Bombay army (for whom, however, no claim of originality has been made), who, on relinquishing that command, returned to England viâ the Red Sea accompanied by Lady Nightingall.[1] Sir Miles and his wife left Bombay in the East India Company's cruiser *Teignmouth*, and after many troubles reached Suez and thence found their way home.

Sir Miles Nightingall, in 1819, and Mount-Stuart Elphinstone, in 1823, return home by this route.

But the first distinct official proposal of this route as one practicable for the regular conveyance of despatches and the mails was made by the Hon. Mount-Stuart Elphinstone, who, when Governor of Bombay in 1823, recommended steam communication between that place and England, remarking that the passage "*might be done in thirty-four days, all stoppages included.*" The Court of Directors, however, paid no heed to this suggestion; and as these sagacious rulers of our Eastern Empire paid quite as little attention to his further communication to them on the same subject in 1826, he thought it advisable to give them a practical illustration of the value of this route by returning home, when he relinquished the Govern-

[1] See "Facts connected with the Origin and Progress of Steam Communication between India and England," by J. H. Wilson, Commander Indian Navy, London, 1850.

ment of Bombay in the following year, with his staff and other friends, by way of the Red Sea and Mediterranean.[1]

His immediate successor in the Government of Bombay, Sir John Malcolm, by returning home viâ Suez (to which reference shall hereafter be made), followed up the good work of his predecessors; and was zealously seconded by his brother, Sir Charles Malcolm, then superintendent of the Indian Navy; while another brother, Sir Pulteney Malcolm, naval commander-in-chief in the Mediterranean, also took an active part in promoting the isthmus of Suez route.

The fact of such men having thus personally and practically directed their attention to the subject, naturally led merchants and others interested in the trade of India to direct their attention with increased vigour to the best means of obtaining more rapid communication with the East. In their researches they were materially assisted by the report of Major C. F. Head,[2] who made the voyage from India to England through the Red Sea early in the year 1829, as again in 1830, being, at the same time, still further encouraged by the successful performances of the

[1] Captain Wilson says (page 7), writing of this journey, "He (Mr. Mount-Stuart Elphinstone) started from Bombay on the 15th November, 1827, in the Honourable Company's brig *Palinurus*, and was accompanied by Mr. C. Lushington, secretary to the Government of Bengal, Mrs. Lushington, Mr. Steele of the Bombay Civil Service, and Messrs. Wallace and Gordon of the Bombay Medical Service. Mrs. Lushington published an interesting account of the journey, thus creating a considerable, though limited, public interest in the route."

[2] See his evidence before Committee of the House of Commons, 1834, on steam navigation to India; and his book, "Eastern and Egyptian Scenery, &c.," with notes, maps, and plans, &c., intended to show the practicability of steam navigation from England to India.

Enterprize and other steam-ships by this time employed in India. Nor did they relax their efforts, dragging with them the Court of Directors, until this great object was accomplished by the establishment of a regular overland mail service.

Mr. Thomas Waghorn visits England to promote the Cape route, 1829–30.

Among the most zealous supporters of steam communication with the East, and subsequently one of the most arduous and conspicuous agitators of the overland route, was Mr. Thomas Waghorn.[1] He had been a mate in the Bengal pilot service, and, having piloted the *Enterprize* on her arrival at Calcutta, at once saw the advantages to be derived from the extension of steam-ships to India. In 1827 he became associated with the committee which had been formed in Calcutta for the prosecution of steam communication with England, and in the following year was accredited by that association to persons in authority at Madras, Ceylon, the Mauritius, the Cape, St. Helena, and London. Failing, however, to obtain

[1] Mr. Waghorn, born at Chatham in the year 1800, was brought up in the Royal Navy, where he served four years. He was afterwards, for twelve years a pilot in Bengal in the service of the East India Company, somewhat later rejoining the Royal Navy, wherein he remained till he passed as Lieutenant. Mr. Waghorn had piloted the *Enterprize* soon after her arrival in India, and from that time devoted his especial attention to steam-vessels. In his evidence before the Select Committee of the House of Commons in 1834 (page 209), he says with regard to himself, "I was selected in 1827 by the Indian Government (Calcutta Steam Committee) for the purpose of establishing steam navigation between England and India. . . . My first object was the Cape of Good Hope. . . . I went to London, Liverpool, and to Manchester; I stated my plans in various parts of the kingdom, and all the success I received after three years' toil, was the *loan* of two fifty horse-power engines from the East India Company." In 1842 he recommended the European route now in use by way of the Adriatic, dying, at length at Pentonville, January 7th, 1850, utterly broken down, and leaving his widow without any means beyond a small pension allowed to her by Government and the East India Company.

sufficient patronage for a regular service by way of the Cape of Good Hope, he resolved to return to India by the Isthmus of Suez, as he had heard that the *Enterprize* was to be despatched up the Red Sea. With that object in view, he waited upon Lord Ellenborough, then President of the Board of Control, and also upon Mr. Lock, at that time Chairman of the Court of Directors of the East India Company, and offered to act as a courier to the East. His services having been accepted,[1] he left London on the evening of the 28th of October, 1829, crossed the continent of Europe to Trieste, and arrived at Alexandria on the 27th of November, at 8 A.M., passing through five kingdoms of Europe in nine and a half days; three days and seventeen hours of this arduous journey having been spent in stoppages. His orders were to meet the *Enterprize* at Suez, and to convey in her despatches for Sir John Malcolm, then governor of Bombay, but, this steamer having broken down on the passage, did not reach her destination.

Returns to India by way of Trieste and the Red Sea.

Though much disconcerted by this misfortune, Mr. Waghorn at once hired an open native boat, and, without chart or compasses, sailed down the Red Sea to Jiddah, a distance of 628 miles, in six days, and, passing on thence, arrived at Bombay, March 21st, 1830, in the East India Company's sloop *Thetis*, which had been sent to meet him.[2]

Still advocates Cape Route, 1830.

Though Waghorn was probably convinced in his own mind by the experience thus obtained of the superior advantages of the Red Sea route so far as

[1] See "Annual Register," October 1829.

[2] Mr. Waghorn, in his evidence before the Committee of 1834, says that, had he met the *Enterprize* at Suez as he expected, he would have conveyed his despatches from London to Bombay in fifty-three days.

regarded speed, he continued to advocate the establishment of a line of steam-vessels by the Cape in preference to any other,[1] no doubt feeling that, in supporting the views of the people of Calcutta, he was honestly performing his duties to those persons by whom he was employed. But whatever may have been the cause, he did not publicly support the overland route until some time afterwards. However, when free to act as he pleased, he took up the cause of the Red Sea route with his usual warmth and energy, and advocated it with more vigour and, certainly, with greater success than he had done that by the Cape of Good Hope.

In the meantime other persons were steadily pursuing their endeavours to induce the East India Company to adopt the overland route, and among these may be mentioned Mr. J. R. Taylor,[2] who had

[1] In the *Bombay Courier* of the 10th April, 1830, there will be found the following *notice* from Mr. Waghorn: "The undersigned feels it his duty to state, for the information of the public throughout the Presidencies of Bombay, Madras, and Bengal, that he is not in any way connected with any scheme for steam-packet navigation with India, except that which he had the pleasure to lay before the Madras and Calcutta Committees in the year 1828, and that any use of his name in reference to it in any prospectus, &c., is perfectly unauthorized by him.

"His motive in wishing this to be generally known is that it may not be supposed by those, on whom he depends for encouragement and support, that he has in any degree departed from his former engagements." (Signed) "Thomas Waghorn."

See also *Bombay Gazette*, 21st April, 1830, where there will be found the report of a public meeting held on the 17th of that month, where Mr. Waghorn advocated the Cape route in preference to that viâ Red Sea.

[2] Mr. Taylor was one of the earliest proposers and founders of the Red Sea route, and had, in 1823, been associated with Lieutenant Johnston, who subsequently commanded the *Enterprize*, and with the Calcutta Steam Committee, from whom he seceded because they relinquished the Red Sea route for that of the Cape of Good Hope. Indeed, he was the first to adventure capital on this route, and

long been as zealously labouring to form a company in London for the establishment of a regular communication by means of steam-vessels on the Mediterranean and the Red Sea. "The experience," he remarked,[1] "afforded by passages made by steam-vessels in certain parts of the route selected, justifies the expectation that intercourse between the two countries may thus be effected in from fifty-four to sixty days;" and, in his letter forwarding a copy of his prospectus to Sir John Malcolm, he adds, "I beg leave respectfully to inform your Excellency, that the requisite number of steam-vessels being already built and equipped, a commencement may be made on the line of communication within three months from the period, when the assent of your Excellency's Government to my proposition may be made known to me. If, then, I should be honoured by such assent, it is my intention, within the period already specified, to be the means of introducing into British India such a number of first-rate steam-vessels, unexceptionable in point of size and equipment, as will enable me to propose myself to become a general carrier to all the Indian Governments, both for England and in India, and will admit of those Governments maintaining a constant and regular communication with Great Britain, and all principal parts of British India, on the first and fifteenth of every month."[2]

Mr. Taylor's proposal.

is said to have lost not less than 12,000*l.* in an endeavour to combine steam-tugs and sailing-vessels.

[1] Prospectus of an establishment of steam-vessels, dated 1st December, 1829.

[2] Letter from Mr. J. W. Taylor, to Sir John Malcolm, Governor of Bombay, 1st December, 1829.

Reply of Bombay Government,

The result of this and other communications addressed by Mr. Taylor to the Government of Bombay, was an official letter from them to the Court of Directors stating that while they considered the Court alone "competent to pass a decision on his proposals," they strongly commended the project he was endeavouring to accomplish. "We beg to add our opinion that no doubt can exist of the practicability as well as the utility of extending steam navigation to Egypt from Bombay; and that we should consider it a most fortunate circumstance if our attempts to promote this desirable object shall, by indicating such to be the case, induce men of enterprise and capital to embark in an undertaking of the nature proposed by Mr. Taylor."

and discussion of the question.

"The plan proposed by Mr. Taylor," they continued, "evidently requires great and combined means to give it even a prospect of success; we are of opinion that his calculations are far too sanguine and that his plan is on too large a scale. These are, however, objections to his scheme which may be easily obviated. In the first instance, we must give our opinion as relates to India that the undertaking may and should be conducted on a more limited scale, and subsequently extended according to circumstances. In transmitting these proposals for your consideration, we cannot avoid expressing our decided opinion that almost incalculable advantages may be anticipated from a well established steam communication by the Red Sea, and our earnest hope that, unless other proposals from individuals have been entertained and their plans put in progress, and in case Mr. Taylor's schemes are viewed as either

inexpedient or impracticable, that every support will be afforded by your Honourable Court to maintain this desirable communication by vessels in the public service."[1]

Supineness of Court of Directors.

But the temper of the Court of Directors was still strikingly in contrast with the earnestness of the Bombay Government. They do not seem to have cared much about the development of the commercial resources of their empire, and so the recommendations of the Governor and Council at Bombay were laid aside for future consideration; indeed, it was not until, after nearly two years, that they even acknowledged the letters they had received. The expense, they averred, exceeded the amount they cared to risk; while, in the proposed undertaking, they had evidently little confidence, as they urged that "the loss from defective vessels and engines is as likely to occur as ever." They, nevertheless, at last affirmed that they were not insensible to the advantages of rapid communication with India nor of the importance of steam for that purpose.

Their views.

"We are also disposed to believe," they added, "that a steam communication by the Red Sea, and still more, if it should be found practicable, by the Persian Gulf and the River Euphrates, would open the way to other improvements, and would ultimately redound to the benefit of this country as well as of India; and, if our finances were in a flourishing state (they were always poor, though ever rolling in wealth), we might probably feel it a duty to incur even the enormous outlay which we have specified

[1] Letter from the Bombay Government (the Marine Department) to the Court of Directors, dated 18th April, 1830.

(100,000*l.*). In the present condition of our resources, we cannot, however, think the probable difference of time in the mere transmission of letters a sufficient justification for the expense. We cannot anticipate that the return in postage and passengers would pay more than a very small portion of the charge." But happily, after other observations, they concluded by saying that, "at the same time we deem the subject too important to be lost sight of or hastily dismissed."[1]

Official report of the first voyages of the *Hugh Lindsay*, 1830.

In the meantime the *Hugh Lindsay* (a war steam-vessel, built of teak at Bombay in 1829 for the service of the East India Company), had fortunately been despatched[2] by the Bombay Government under command of Captain J. H. Wilson, from Bombay to Suez and back—a voyage, I may add, which was

[1] Letter from the Court of Directors to the Governor in Council at Bombay, Public Department, 14th March, 1832. To this opinion of the Court I may add that Mr. Peacock, the "senior assistant examiner in the East India House," in his evidence before the Committee of 1834 (pp. 3 and 4) when asked, if he thought any returns might be anticipated for postages and passengers to justify an expenditure of 100,000*l.* per annum in establishing and maintaining a quarterly steam service overland by way of Suez between England and India, would pay, replied: "*I think nothing to pay the expense; something certainly, but not above one-fourth of the amount.*" The gross earnings of the Peninsular and Oriental Steam Navigation Company alone between 1856 and 1874, inclusive of the amount received for the conveyance of mails, passengers, and cargo, amounted to 41,546,818*l.*

[2] The *Hugh Lindsay* sailed *for* Suez on her first experimental voyage on the 20th of March, 1830, the day before Mr. Waghorn arrived at Bombay in the *Thetis*; and she continued in that service under command of Captain Wilson, making one voyage annually, during the north-east monsoons till April 1836, when Captain Wilson was appointed Controller of the dock-yards at Bombay as an acknowledgment of his services, for it is unquestionable that he did much to "educate" the Governments of England and India on the importance of the overland route, as appears by the official correspondence of the period.

twice repeated before the Court of Directors gave any instructions on the subject, though one, too, materially tending to solve some at least of the difficulties they had contemplated. It was on the second of these occasions that Sir John Malcolm and his suite made the overland passage to England.

"When it was determined," remarks Captain Wilson, "that the *Hugh Lindsay* should attempt the voyage to Suez, it became necessary to put on board double the quantity of coal the vessel was built to carry, to do which, a great part of the space originally intended for accommodation was appropriated to the stowage of coal; water also was necessary, sufficient for use until the vessel should reach land in the event of a break-down between Bombay and the first depôt; as also stores and provisions for the whole voyage to and from the Red Sea."[1]

Captain Wilson, however, accomplished the passage from Bombay to Aden, a distance of 1641 miles, in ten days nineteen hours, though only six hours' coals remained on board when he arrived at that port. At Aden the *Hugh Lindsay* obtained a fresh supply, coal depôts having been established in anticipation of her arrival at that place, as well as at Jiddah, Cossier, and Suez. Other difficulties, however, had to be overcome, as scarcely a day passed without it being necessary to stop the engines to put the paddle-wheels in order, the boards of which were constantly getting loose. At Aden, Captain Wilson was detained five days and twenty hours in receiving the necessary supply of coal, owing to the want of means at the place for shipping it and other

[1] See note (2), p. 352.

obstacles. The passage from Aden to Mocha roads, where he had despatches to land, was accomplished in twelve hours, and thence to Jiddah, a distance of 557 miles, in four days twelve hours. Here his vessel was detained four days and a half in obtaining a supply of coals; in five days more he reached Suez, having performed the voyage from Bombay to Suez in twenty-one days six hours' steaming, or, including stoppages, in thirty-two days sixteen hours.

Had a steamer been ready at Alexandria the mails (consisting of 306 letters, the postage on which amounted to 1176 rupees), which could have been conveyed thence in three days, would in twenty-five more days have reached England. Thus, in spite of the delays at the depôts, the communication between India and England could have been accomplished in sixty-one days. The return passage of the *Hugh Lindsay* to Bombay occupied thirty-three days, including stoppages of nineteen days, or fourteen days' steaming; and, under all the circumstances, the whole voyage was considered far from unsatisfactory;[1] one of the subsequent voyages, to Cossier[2] (300 miles below the Isthmus), was accomplished in twenty-two days, including five days' detention at the coaling stations.

Yet, though the practicability of the Red Sea voyage during the north-east monsoon was now demonstrated, it was not certain that the passage could be made irrespectively of the seasons; nor could any argument be drawn from the performances of

[1] For an account of the voyages of this ship in detail see Report of the Committee of the House of Commons, 1834.

[2] Cossier, which is about 100 miles from the Nile, was one of the ports of departure for the vessels of ancient times engaged in trade with the East.

this pioneer ship, as her construction and power were not suited to contend against the south-west monsoon between Ceylon or Bombay and the Arabian Gulf.

Again, as a large number of persons connected with the East India Company, and various merchants interested in trade with the East, many of whom had advocated the Cape route, were now in favour of the Euphrates route, though the public in general preferred the establishment of a mail service by way of Egypt, the discussions, ultimately arising, led to the appointment of the Parliamentary Committee of 1834, the resolution of the House simply requiring its members "to inquire into the means of promoting communication with India by steam."

Report of Committee of 1834.

But the report of the Committee, after a very full inquiry, was not definite on the point of the really best route. It was, however, resolved, and the Committee could hardly have done otherwise, notwithstanding the lukewarmness of the Court of Directors, that a regular and expeditious communication with India by means of steam-vessels was an object of great importance both to Great Britain and to India; that the practicability of steam navigation between Bombay and Suez *during the north-east monsoon* had been established by the *Hugh Lindsay*; but that further experiments were necessary to establish the practicability of the Red Sea route at all seasons of the year. They further recommended that a grant of 20,000*l.* should be made "with the least possible delay," to examine and test the steam capabilities of the Euphrates route; the line contemplated being that from Scanderoon on the coast

of Syria to Aleppo, and thence to Bir on the Euphrates, the distance between these towns (170 miles) being not greater than that across Egypt.

From the evidence adduced and from the correspondence in the public journals of the period,[1] it is, however, evident that political rather than commercial reasons favoured the Euphrates route. It was then thought, looking to the probability of the opening up of the Indus, to the state of our relations with Persia, and to the necessity of maintaining a squadron, as we then did, to protect our interests in the Persian Gulf, that this line could, while increasing the safety of our East Indian possessions, be maintained at less cost than the Red Sea one.[2]

[1] The reasons for preferring the Euphrates route, are given at great length in the *Bombay Gazette*, 7th August, 1833.

[2] To question 64, p. 6 (Committee, 1834) "Would there be any *political* or other advantages in our opening the line of the Euphrates?" Mr. Peacock replies: "I think it would be highly serviceable, if possible, to prevent Russia pre-occupying it and excluding us; it would be exceedingly easy for Russia to follow the steps of Trajan and Julian, construct fleets in Armenia, and float them to Bussorah; they have the possession, at least the command, of the Armenian part of the Euphrates now."

"Would there not (question 65) be more danger to be apprehended from the Russians from their making use of the Oxus and Caspian, than by making use of Bussorah, where they would be met by the nation which happens to have the pre-eminence at sea?"—"But the pre-eminence at sea," Mr. Peacock replies, "is not a talisman; it is to be kept up by constant watchfulness, and the exertion of adequate force. I know there is danger by the Oxus, but there is also danger by the Euphrates, and I would stop both doors, if I could." In reply to further questions (66) he says: "The first thing the Russians do, when they get possession of, or connection with, any country, is to exclude all other countries from navigating its waters;" and in reply (question 67) to "How the establishment of steam along the Euphrates would serve in any respect to counteract Russia?" he says, "It would give us a vested interest and a right to interfere;" adding "they (the Russians) have been long supposed to have designs on Baghdad; they have had emissaries there a good while; the Pashalic of Baghdad is a very

The other reasons assigned in favour of the Euphrates route were the comparative cheapness with which this object could be accomplished, the channel of the Persian Gulf and the River Euphrates being preferable to that of the Red Sea for steam communication between Bombay and the Mediterranean; moreover, in the then existing state of things it was thought that the route by Syria, Mesopotamia, and Babylonia would be safer than by way of the Red Sea and Egypt. In reference to the dangers which might be encountered from the wandering tribes of Arabs who had so long infested a large portion of the Euphrates route, it was stated that arrangements could easily be made by negotiations with the Porte, Mohammed Ali, or the chiefs of the tribes, who, at a small annual cost, would insure the necessary protection, while it was held that an armed mail-steamer with only letters and ordinary stores on board, would offer no attraction to marauders, as it was not then contemplated to carry either treasures or valuable merchandise by the overland route.[1]

Decision of House of Commons Committee influenced by political considerations.

As the Committee of the House of Commons had recommended immediate action for the establishment

valuable possession, and would pay for protecting it, either to them or to us."

Mr. William J. Bankes (and others) entertained similar opinions. In reply to (question 2626) "What is your opinion of the political advantages between the one and the other?" he says, "It is *very* much in favour of the Euphrates." "Will you state in what respect?" (question 2627) "I think by anticipating the Russian, you will exclude him; I think he will afterwards, perhaps, do that by force which you could now, perhaps, do by treaty."

[1] For Colonel Chesney's elaborate report on the advantages of the Euphrates route, I must refer my readers to the Appendix of the Report of the Committee of 1834.

of a regular overland mail service, the Court of Directors were compelled to take the matter into their serious consideration; but they had determined to leave for future consideration the important question whether the communication should be, in the first instance, from Bombay or from Calcutta, or according to the combined plan suggested by the Bengal Steam Committee, in which case the nett charge should be divided equally between the Government and the East India Company, so as to include the expense of the land conveyance from the Euphrates and the Red Sea respectively to the Mediterranean. After reviewing the relative advantages on the one hand and the physical difficulties on the other of the two routes, with the view of securing a regular communication throughout the year, the Committee suggested an extension of the line of Malta packets to such ports in Egypt and in Syria as would enable the communication between England and India to be tested experimentally by both routes.

Admiralty packets extended from Malta to Alexandria.

In accordance with these recommendations the Admiralty extended, in February 1835, the service of their mail-packets from Malta to Alexandria; while the Court of Directors sent out instructions to the Governor-General of India to forward the *Hugh Lindsay* at appointed periods to Suez. The character of the Euphrates route was also still further explored by Colonel Chesney,[1] under the direction of the East India Board, to whom this work had been entrusted,

[1] In furtherance of these instructions Colonel Chesney made a most elaborate survey, and wrote a voluminous book with maps, for which he, some time afterwards, was compensated by a grant of 4000*l*.

and, not long afterwards, the home authorities established a dromedary post from Baghdad to Damascus and Beyrout for the transmission of such mails as might be sent by that route.

The beneficial effects of these arrangements were soon felt in India, as would appear by a despatch from the Bombay Government to the Court of Directors (September 1836), wherein it is stated "that the three last overland mails have brought despatches from London to Bombay in thirty-eight, forty-five, and sixty-four days, and those intended for Calcutta have been forwarded in ten days more." But as the despatch of the 16th of September, which conveyed this information by way of Egypt, did not reach England till the beginning of the following year, owing to various delays between Bombay and Suez, it was resolved to place larger and more powerful steamers on the Red Sea route—chiefly, as it would seem, because neither the *Hugh Lindsay* nor the *Enterprize* could perform the passage against the south-west monsoon.

Steamers of the Indian Navy.

The result was that the Court of Directors placed on this station (that by the Euphrates presenting greater difficulties) two vessels of much superior power, the *Berenice* and *Atalanta*, which had been laid down in 1835 for their naval service. The particulars of these vessels and of their cost, as well as those of the steamers on the Red Sea service which followed, will be found in the Indian navy list supplied by the East India House to Lord Jocelyn's Committee of 1851, from which see extract.[1]

[1] Return of the number, cost, ages, power, tonnage, and speed of steam vessels forming the Indian Navy, distinguishing the vessels

A regular steam service having now been established between England and her Eastern empire by ships of the East Indian navy on the one side of the Isthmus of Suez, and by the Admiralty packets on the other, I shall glance at the various means of transit across this neck of land, before describing the great mercantile steam lines which now maintain the communication throughout.

Modes of transport across the Isthmus of Suez.

At the outset they were of the most original and multifarious description, and the few passengers who then made the overland passage found their way as best they could on camels, dromedaries, or donkeys. Towards the improvement in all its stages of this rude mode of transport there was no one more conspicuous than Thomas Waghorn. He was the moving genius of the whole undertaking, and its most zealous and successful agitator. Whatever may

employed on the Bombay mail line, so far as the same can be made out. (They were all built of wood, and propelled by paddle-wheels):

Names of Vessels.	Cost.			Ages.	Horse Power.	Tonnage.	Speed	——
	£	s.	d.				Knots per Hour.	
Acbar . . .	76,373	9	8	built 1841	350	1,143	$8\frac{1}{2}$	Employed on the Bombay Mail Line.
Ajdaha . .	80,515	16	5	„ 1847	500	1,440	8	
Atalanta . .	36,651	17	10	„ 1835	210	616	$7\frac{1}{4}$	
Auckland .	43,052	3	2	„ 1840	220	946	..	General Service.
Berenice . .	40,123	11	6	„ 1835	230	664	..	
Feerooz . .	67,219	0	0	„ 1846	500	1,440	$8\frac{2}{3}$	Employed on the Bombay Line.
Medusa (iron)	9,972	18	1	„ 1840	70	432	..	General Service.
Moozuffer .	81,576	9	6	„ 1846	500	1,440	..	
Queen . . .	44,409	17	11	„ 1839	220	760	..	
Semiramis .	43,447	12	8	„ 1840	300	1,000	..	
Sesostris . .	52,388	8	2	„ 1839	220	876	..	
Victoria . .	39,820	15	6	„ 1839	230	714	$6\frac{5}{8}$	Employed on the Bombay Mail Line.

be said of his prudence, or however much we may lament his failings, his industry was unwearied and his zeal unbounded. It may be that he was only a convert to a scheme long contemplated by others; but, when once undertaken, his efforts never ceased until the object he had in view was accomplished. Though the first resting-places across the desert were constructed at the expense of the Bombay Steam-fund Committee by Hill and Raven,[1] under the orders of Colonel Barr,[2] the route itself was organized by Waghorn, and he was the first *who undertook and carried on by a regular system for three years the conveyance of the mails across the Isthmus of Suez.*[3] Sir Gardner Wilkinson ('Modern Egypt,' pp. 306–7) and various other competent witnesses bear ample testimony to this important fact, and it is one which must ever hold a prominent place in the records of the origin of the modern overland route to India. Great exertions of Waghorn in the establishment of this route.

Though camels are capable of carrying a weight of from 9 to 10 cwt. each at a rate of 2½ miles an hour[4] for twelve or sixteen consecutive hours, it became necessary to adopt other modes of transit as the traffic increased. Two-wheeled vans drawn

[1] Hill was an engineer, and Raven a wheelwright in the service originally of Galloway Bey, and, subsequently, in that of the Pasha of Egypt, Muhammed Ali, who, when they were in difficulties to carry on their work, rendered them pecuniary assistance.

[2] Mr. Waghorn, in his evidence before the House of Commons Committee of 1837, says (question 53), "I can send Mr. Hill and other men of the service at an hour's notice from Cairo," &c., by which it appears they were then, at least, under his orders.

[3] In a note I received from Sir Daniel Lange (12th March, 1875), he remarks: "M. de Lesseps often told me how he met Waghorn struggling with man and beast in the desert to carry his mails across, and that it served as an example to him in after-life with the Suez Canal."

[4] See evidence before Committee of 1834 by Mr. Peacock, pp. 2 and 3.

by four horses, and fitted to carry eight persons, were therefore introduced to transport the passengers from Suez to Cairo, whence they were embarked in sailing boats on the Nile to Alexandria; Mr. Waghorn subsequently organizing, in connection with the Peninsular and Oriental Steam Navigation Company, a line of small steamers which took the place of these boats. In course of time caravansaries and hotels were substituted for the original stations and resting-places on the route. These were completed in February 1843, and received the passengers from the *Hindostan* steamer on her first trip in the regular mail service from Calcutta, Madras, and Galle to Suez, by which time this branch of the business had been undertaken by the Egyptian Transit Company. But, in the organization of all these important works, Mr. Waghorn took the leading part, and their completion, under many difficulties, was in a great measure due to his indefatigable exertions.

So early as 1834, Muhammed Ali, seeing the advantages to be obtained by a railway between Cairo and Suez, instructed Mr. Thomas Galloway to make arrangements for its construction, and, with this object in view, the rails, locomotives, and plant, were ordered from England;[1] but, owing to the opposition of France, the formation of this line was continually postponed,[2] and subsequently abandoned.

[1] Messrs. Galloway Brothers (see evidence before Committee of 1837) had established at Boolak (a suburb of Cairo) an extensive iron manufactory, and were in a position to carry out the Pasha's railway, for which they had imported plant by his orders to the value of 200,000*l*. Whether any portion of this was used by Mr. Stephenson, who subsequently constructed the railway, does not appear.

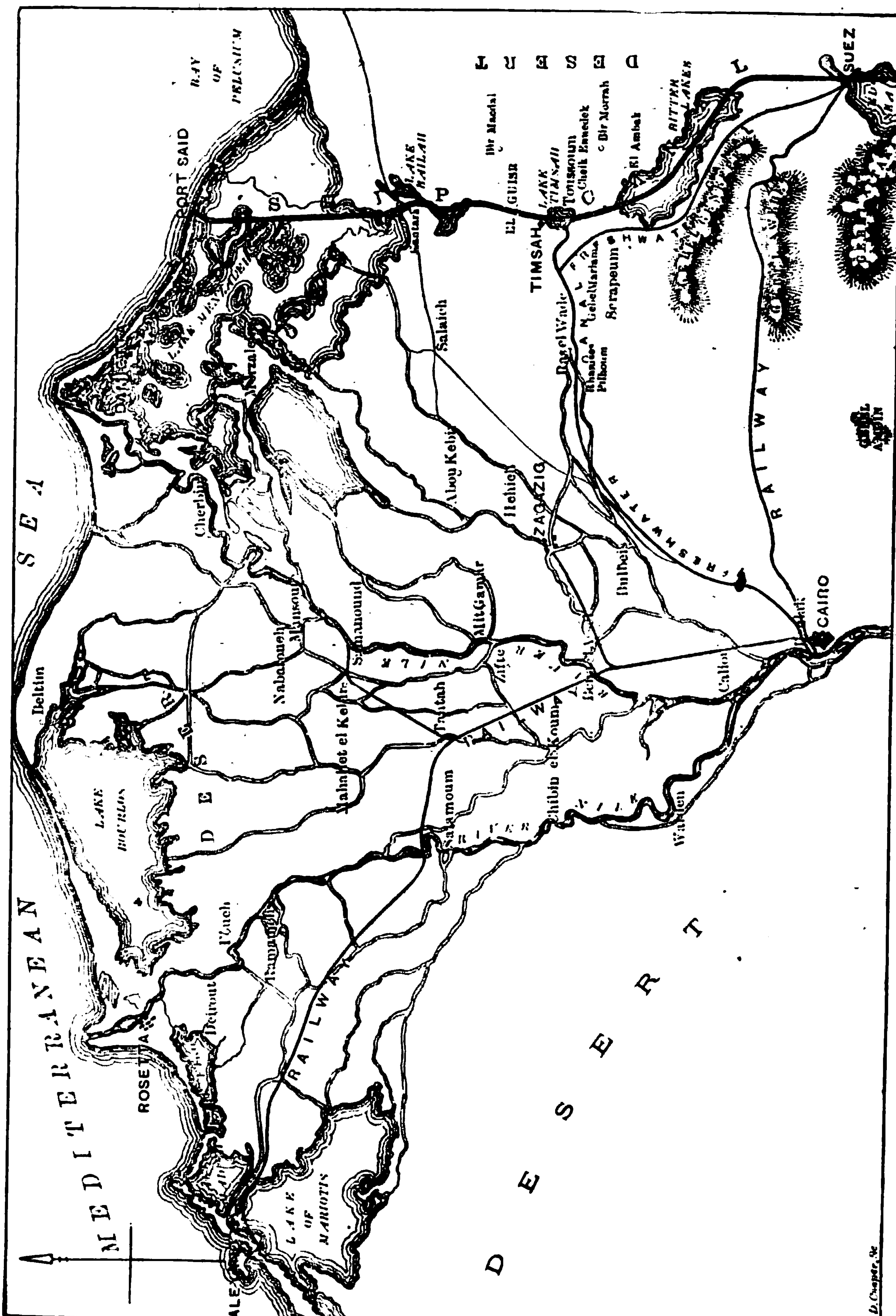
[2] Pamphlet by Mr. R. H. Galloway (pp. 15 and 17), published by Willis, Sotheran, and Co., London, 1871.

A railway was, however, commenced in 1852 by Robert Stephenson from Alexandria to Cairo, and completed in 1857. Subsequently, it was continued from that city to Suez, branching off at Benha to Zaga-Zig, and following the course of the old canal to Suez, by which a considerable saving of distance was effected over the Cairo route as originally proposed. The line throughout was completed and opened for traffic in 1870.

But the grand work, the greatest and grandest connected with maritime commerce, either in ancient or modern times, was the cutting of the Suez Canal, between the town so named at the head of the Red Sea and the shores of the Mediterranean at a place in the Bay of Pelusium, now known as Port Said: this gigantic undertaking is about 100 miles in length, and runs in nearly a straight line almost due north from Suez, passing through various lakes, marshes, or swamps, the principal of which are called Birket Menzaleh, Birket-el-Timsah, and the Bitter Lakes. Suez Canal.

Previously to the commencement of this great work, at least two erroneous impressions had prevailed: of these the first, that the Mediterranean was from 25 to 30 feet below the level of the Red Sea at Suez,[1] has been exploded by the completion of the canal; but, as the second (reflecting on the originality of M. de Lesseps' undertaking), though a much less important one, seems still to exist, I may state that the course of his canal is quite different from that of the fresh-water one said to have been navigable in

[1] Evidence of Major Head, Mr. T. T. Peacock, and others, before the Select Committee of 1834.



MAP SHOWING SUEZ CANAL, WITH SURROUNDING COUNTRY AND THE POSITION OF THE OLD CANALS.

the reign of the Pharaohs (its course is still traceable here and there), which ran from a point on the Nile a little below Cairo in a north-easterly direction, towards Lake Timseh, and, thence, almost due south by the west side of the Bitter Lakes to Suez. This canal had no connection, or rather water communication, with the Mediterranean except by the easternmost branches of the Nile below Cairo, and, though the Nile at that city is ten feet above the Red Sea at Suez, it may be doubted whether this ancient canal was ever used except during the rainy season, though Herodotus states there was width on it for two triremes to row abreast. Certainly, no mention, direct or indirect, records the passage of any craft worthy of the name of a ship between the Mediterranean and Red Sea.[1] The great ship-canal (see map, p. 364), now in use, does not go near

[1] The truth about these ancient canals seems to be as follows:

1. According to Herodotus, Pharaoh Necho commenced one from the Nile to the Red Sea (ii. 158) which he says was completed by Darius the son of Hystaspes (iv. 39). This canal, we may fairly presume, was open when Herodotus was in Egypt, as he states it was four days' journey in length, and wide enough for two small triremes to row abreast; it is doubtless the one attributed by Aristotle, Strabo, and Pliny to Sesostris—an identification confirmed by the fact that, in recent times, tablets bearing the name of Rameses (Sesostris) have been found on the site of its present dried up bed. As far as can be now ascertained, it would seem that this canal left the Nile at or near the city of Bubastis (now Tel Basta). The discovery of a Cuneiform inscription of Darius near Suez, gives colour also to the traditional story which refers to him. Diodorus, notices the proverbial opinion of the height of the waters of the Red Sea (i. 33) and adds, that this canal was completed by Ptolemy when he built Arsinoe.

2. There is no doubt that this canal continued in some use under the Roman Emperors, as Trajan formed a new connection for it by a cutting at Babylon (Old Cairo) (Ptol. Geogr. iv. s. 54), and, further, Sir Gardner Wilkinson has shown that the whole line from the Nile to the Gulf was restored by the Khalif Omar, and was in use for a century and a half after his time. The work of Necho appears also to have

Cairo or the Nile, but cuts through the narrowest part of the isthmus at a point about 100 miles east of Alexandria.

Popular errors on this subject.

A popular error also prevails that this vast undertaking was only contemplated a few years ago. Nor do these popular errors here end, for everybody supposes that M. Ferdinand de Lesseps, to whose genius and energy the world is indebted for this great work, was an *engineer*, whereas he was really a *diplomatist*,[1] and was obliged to make himself master of the art of engineering to be in some measure able to cope with the host of engineers, professional and theoretical, who opposed his marvellous scheme.

M. de Lesseps.

The idea of a canal across the Isthmus of Suez by the route adopted by M. de Lesseps is a very old one. So far back as A.D. 638–40, Amrou, soon after the conquest of Egypt,[2] wrote to his master the

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included a canal from the head of the gulf to the Pelusiac mouth of the Nile, as of this considerable remains still exist.

3. It may be further remarked, that the bed of the Bitter Lakes was, even in the time of Strabo (xvii. p. 804), filled with Nile water, as the same fish were noticed in both. At the same time, we may be sure that nothing like a ship (in our sense of the word) ever passed through the isthmus until M. de Lesseps completed his great work.

[1] Ferdinand de Lesseps in his youth was attached to the Consulate at Lisbon, and then, in 1828, to the Consulate-General at Tunis. In the following year he was appointed Vice-Consul at Alexandria, and in 1832 he was advanced to be Consul at Cairo, where he remained for seven years. In 1842, he received the appointment of Consul-General at Barcelona; in 1848 he went to Madrid as French Minister Plenipotentiary; and later on, to an important mission in Rome, after which he retired to Berri (France) to mature his plans for the Suez Canal, which had been the almost constant subject of his thoughts since his residence in Cairo.

[2] See a very interesting paper read by Mr. (now Sir Daniel) Lange before the Society of Arts, London, April 27th, 1870.

Khalif Omar recommending the establishment of a communication between the two seas, the intervening country being, as he describes it, "an undulating green meadow with ploughed fields—such is the delta of the Nile; a dusty desert, a liquid and clayey plain, a black slush—such is the isthmus to cut through." But the Khalif objected to the piercing of the isthmus, "fearing it would open out the country to the influence of foreigners," a fear that prevailed also with one or two leading statesmen of our own country and in our own time.

Though the project had been occasionally mentioned, the work itself was never seriously contemplated except in one instance [1] until M. de Lesseps, about the year 1840, conceived a definite plan for carrying it out. Scientific men, indeed, in most parts of the world, considered the undertaking altogether impracticable. They alleged that the difficulties of the desert could never be surmounted, and that nothing stable could be erected on treacherous sands doomed by nature to sterility and desolation.[2]

[1] It is fair to recollect that my old friend and colleague on the Harbour of Refuge Commission, Captain Vetch, R.N., more than thirty years ago (and therefore before M. de Lesseps) proposed a ship canal from Suez to Tinch, on the Mediterranean, a distance of about 75 miles, to be carried out by British capital. At that time the idea of the height of the water at Suez above that of the Mediterranean prevailed. Captain Vetch therefore calculated that, with a canal 180 feet wide at the top, 96 feet at the bottom, and 21 feet in the depth, the steady descent of the water along this gradient would produce scourage sufficient to clear away the sand and mud accumulated at the Mediterranean end. No doubt Captain Vetch's observations and details tended to satisfy M. de Lesseps of the feasibility of some such canal.

[2] Some preparatory steps had also been taken which, by getting rid of unscientific hypotheses, facilitated in some degree M. de Lesseps' views. Thus, at the suggestion of the Viceroy, the English, French, and Austrian Governments had sent in 1847 a joint commission of scientific

Indeed, Sir Daniel Lange,[1] the oldest and most earnest friend and colleague of M. de Lesseps in this country, and, from its commencement until now, the representative of the Suez Canal in England, remarks that so general was this opinion, that the captains of the small craft who first received orders to proceed to Pelusium with materials for the prosecution of the work, smiled with incredulity, but resigned themselves to what they thought a fool's errand.

His great scheme.

Nor were these doubts surprising, for the site of ancient Pelusium is upon a low flat shelving sandy coast where sea and land seem to blend with each other, and where the long roll of the surf over a flat beach forbids even the approach of a boat. No wonder therefore that the indefatigable M. de Lesseps was unable for years to induce either governments or individuals to provide the requisite means; indeed, his own countrymen, when he issued the prospectus in 1857, were nearly if not quite as lukewarm about it as foreigners, while in England on the

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men to take the various levels on the isthmus of Suez, especially as regarded the relative heights of the water in the two seas. Mr. Robert Stephenson represented England; M. Talabot, France; M. Negretti, Austria; and Linant Bey, the Pasha. Stephenson watched the rise and fall of the tide at Suez and Negretti at Tineh, the result being the demonstration that the two seas have exactly the same level within a few inches. A full account of the plan developed by M. Talabot from the observations of this commission will be found in the "Révue des Deux Mondes," and there seems little doubt that, but for the determined opposition of Mr. Robert Stephenson, whose imagination (to the day of his death) was perpetually haunted with ideas of the sand, silt, and mud with which he maintained *any* canal must be filled up, the great work, which was the glory of M. de Lesseps, would have been carried out by English enterprise some years earlier than 1869.

[1] Sir Daniel Lange was knighted after the opening of the Suez Canal. He is a native of London, and the holder of various foreign honours. He unsuccessfully contested Midhurst in 1868.

other hand, a great outcry was created, mainly by Lord Palmerston, against the project on political grounds. It is not, however, my province to enter upon these; but, surely, England, with her vast possessions in the East and with the command of the sea, was far more interested than any other nation in removing Egypt from the envy it had long been of powerful European nations, and, in cutting a ship canal—a great highway—through it, which would be open to the vessels of all nations like the Sound or the Dardanelles. Indeed, every increased facility for reaching our Indian possessions must be a far greater gain to us than to any other nation.

Not fairly considered in England.

But strange to say the political opposition raised by England[1] proved the chief means of enabling M. de Lesseps to raise the requisite capital, and secured him support he would otherwise not probably have obtained. Foreign capitalists, especially in France, now came forward to subscribe, not that they had much faith in the commercial success of the canal, but because they felt grieved or annoyed that an undertaking, which could not fail to benefit mankind, even if it did not pay the original subscribers, should be opposed on narrow and jealous grounds by one of the most conspicuous, if not in all matters the most enlightened, of English statesmen.

But, even with the requisite capital at command, M. de Lesseps had a most arduous and herculean task to perform. It was necessary, remarks Sir

Commencement of M. de Lesseps' works, 1857.

[1] Not however by all her statesmen, for Mr. Gladstone, Lord Russell, Sidney Herbert, Mr. Cobden, Mr. Bright, Mr. Milner Gibson, and others strenuously objected to any hostile interference on the part of Government with the project.

Daniel Lange, previously to entering on a work of such magnitude, to prepare dwellings, storehouses, factories, forges, and a lighthouse; indeed, all the accessories indispensable for putting in motion the huge mechanical appliances intended to be used. All this was done in the newly erected "Town of Port Said." But before this place could be formed, the marshes had to be raised 10 feet above the sea-level, so as to form an area of sixty-seven acres of solid land; and from this basis piers had to be carried out into the open sea, the western one for a distance of one and three-quarter miles, and the eastern a mile and one-third in length, composed of not less than 250,000 blocks of concrete, weighing about thirty tons each. Between these piers a harbour was formed with a surface of 132 acres, the excavations from it amounting to 4,669,943 cubic mètres.[1]

General details.

But among the many obstacles encountered, none were half so formidable as the formation of the channel through Lake Menzaleh, which extended 21 miles from Port Said to Kantara. The sands and other insurmountable obstacles which had been prophesied were as nothing to this work, arising from the fact that the mud and slush had actually to be thrown up by the hands alone (just as children in their amusements make mud-heaps) of the thousands of natives employed to form a dyke;[2] indeed, had it not been for the

[1] My readers will find an excellent account of the early works of the Suez Canal, in a little book published by Mr. A. K. Lynch, entitled "A Visit to the Suez Canal," Lond. 8vo. 1866, with several excellent lithograph drawings of Port Said, Ismailia, and other places on it. A French mètre is 39 English inches or 1-19th more than an English yard.

[2] Herodotus (132) speaks of the vast amount of forced labour employed in the construction of the great Pyramids; hence various writers, recalling the hardships these "slaves" had to endure, protested against

powerful Egyptian sun, which dried up the mud so exposed in a few hours, the task would have been impracticable, as ordinary mechanical appliances must have failed to overcome such an obstacle.

When something like an opening had been made through many miles of "black slush," and clear water began to flow in, rafts were constructed, and on these the men slept under tents made of mats. In this work, about fifteen thousand fishermen from the neighbourhood were employed, a class of men who, from time immemorial, had been accustomed, in their ordinary avocations, to spend a large portion of their time half immersed in the water.

When a passage of sufficient dimensions had been scooped out with their hands, dredging-machines were introduced. By degrees this trench was widened until it reached the dimensions of 330 feet wide, and 26 feet deep; the sides, from the rapid drying of the mud, soon becoming almost as solid as walls of masonry and quite as durable.

It was between these new banks that floating dredging-machines of a novel construction, with shoots 220 feet in length, were placed, thus enabling M. de Lesseps to dispense with the previously expensive mode of conveying the silt raised by the dredgers in hopper-barges to sea; the new machines discharged the stuff excavated from the channel over

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the employment of "similar bodies of men" in the construction of the Suez Canal, commenting on the scandalous treatment to which they were subjected. But I have enquired minutely into this question, and I cannot find any just grounds for these complaints. On the contrary, the men employed appear to have been free labourers, fairly remunerated according to the work they performed, and, on the whole, kindly treated.

the embankments on to the low and marshy land on either side:[1] by these means two good results were attained; the channel of the canal was economically cleared, and the mud thus excavated employed in greatly strengthening its banks on each side.

The cutting of the channel through Birket-el-Ballah, which was more of a swamp than a lake, for a distance of twelve miles, though in itself a very difficult work, was comparatively easy to the excavation of Lake Menzaleh, nor were there any serious obstacles to encounter except in clearing a passage through various mounds of earth extending for a distance of 6 miles, all of which had to be removed or pierced. This difficulty, however, was overcome, after a passage had been cut, by the aid of an ingenious machine called an elevator, which lifted the soil to a height of 56 feet, and carried it along a kind of railed bridge to the places of deposit on either side of the excavated mounds. Eighteen of these elevators, with 700 boxes, were employed on that portion of the works where the banks of the canal were too high to allow the earth cut from the channel to be otherwise disposed of. One of these mounds, that of El Guisr, 61 feet in height, presented a most formidable rampart, which had to be removed in order to allow the waters of the Mediterranean to flow into the vast local depression immediately beyond it known as Lake Timsah, by Ismailia, the interior port of the canal, so named in honour of the Khedive. Here a flourishing new town has been built, surrounded by gardens growing

[1] Besides the dredging-machines and men employed, there were at work upon the canal during the last six months of 1864, 42,929 camels, 9350 horses, 2489 mules, and 2835 donkeys.

in a fruitful soil, on a site for many centuries a bleak and sterile desert.

In the work of removing these mounds, or cutting through them, so as to form the channel of this great maritime highway, where ships of 4000 tons now safely navigate, every conceivable description of machinery suitable for the purpose had to be prepared beforehand, together with not less than 20,000 workmen, including a perfect army of Fellaheen, the usual designation of the rural population which the Government of Egypt had agreed to supply, and various tribes of Arabs and Bedouins from the countries bordering the Syrian deserts. These men were divided into gangs, and their work apportioned with great order and regularity; in each division a notice in Arabic was posted indicating the quantity of earth to be dug, and the wages paid per cubic mètre for its completion. Nor were the wants and social comforts of these men overlooked. Large encampments were provided, and arrangements made for an abundant supply of provisions and fresh water, the latter alone during some portions of the work having to be brought twenty miles, thus affording constant employment to 2000 camels, each of which carried about 50 gallons or about 500 pounds weight of fresh water. From Timsah to the Bitter Lakes the excavations through the district called Serapeum, were hardly less formidable. "Historians," remarks Sir Daniel Lange,[1] "tell us that these lakes were in ancient times, the limit of the Gulf of Suez. One thing is certain, that the shells and fossils found here are of the same species as those in the Red Sea.

[1] Paper read to Society of Arts, p 7.

The conjecture the least contradicted is, that an earthquake caused the upheaving of these parts and the sea to recede to Suez, leaving the lakes and interior basin which in process of time have evaporated."

These lakes are 16 and 9 miles in length, respectively: the first descending from the heights of Serapeum, being 34 feet below sea-level, and the second 24 feet. In both, isolated water lines of high and low tides are easily discerned, with remains of gravel, and of a horizontal bank of agglomerated fossil shells about 7 feet thick. M. de Lesseps found them completely dried up, with the exception of the lowest portion, which still retained enough humidity to make the earth moist and in some parts swampy. To fill these deep basins, water was drawn, by means of sluices from the Red Sea and from the Mediterranean; and, on the 18th of April, 1869, when these were opened in the presence of the Khedive of Egypt, the waters of the two seas, for the first time embraced each other, though it was not till the 15th of August that the great maritime canal was open throughout. The inauguration of their complete union was celebrated at Suez, and, on the 28th September, M. de Lesseps steamed from sea to sea in fifteen hours, having accomplished by his genius and unwearied industry one of the greatest engineering works the world has ever seen, and given to posterity, as a great benefactor of the human race, another imperishable name.

Partial opening of Canal April 18th, 1869.

Finally opened by Empress Eugénie November 17th, 1869.

On the 17th of November, this important maritime canal was formally opened for ships of all nations with much state by the Empress Eugénie of France,

in the presence of numerous distinguished men from all countries.

The cost complete, was somewhat about 20,000,000*l.* sterling, consisting of 8,000,000*l.* subscribed capital, 4,000,000*l.* debenture stock, and 8,000,000*l.*, in further loans and indemnities paid by the Khedive for retrocession of lands, &c.

To the traffic now engaged upon it I shall hereafter refer. In the meantime, I must trace the rise and progress of the first mercantile steam-ship company which developed the trade of England with her Indian possessions by way of the Isthmus of Suez.

CHAPTER X.

Peninsular and Oriental Steam Navigation Company—Its founders and origin—Messrs. Willcox and Anderson—Mr. James Allan—How the Peninsular mails were originally conveyed—Proposal of Peninsular Company for their conveyance—Contract concluded August 29th, 1837—Conveyance of mails to India previously to 1839—Government applies to the Peninsular Company and accepts their proposals, though reluctantly—Proposed direct line from Falmouth to Calcutta—First vessels hence, on Indian postal service to Alexandria—Original postal service from Suez to Bombay—Contract for mails between Suez and Calcutta, September 1842—Further proposals made by the East India Company and Government, but finally rejected by the East India Company—Further contracts for mail service to China and Singapore—Peninsular and Oriental Company undertake the line between Bombay and Suez, 1854—House of Commons Committee on Australian mail service, 1849—Eastern Steam Navigation Company and Peninsular and Oriental Company tender for it, but the Peninsular and Oriental succeed—The *Himalaya* built—New contract with Peninsular and Oriental Company, January 1853—Failure of service during the Crimean War—Proposals for an independent Australian mail service—Tender of European and Australian Company accepted—Their entire failure—Speech of Lord Overstone, March 24th, 1859—Royal Mail Company undertakes the Australian service and fails—New tenders invited—That of Peninsular and Oriental Company accepted, 1859—Consolidation of services in the Peninsular and Oriental Company—Its present condition and fleet of ships—Terms of the contract now in force—Revenue and expenditure—Coals required—Descriptions of vessels—Screw steamer *Khedive*—Particulars of this ship—Uniform and regulations of the company.

Peninsular and Oriental

THE career of the Peninsular and Oriental Steam Navigation Company, the first commercial under-

taking which conveyed the mails overland to the East is interesting and instructive. It is the more so, as the impression that this company owed its origin to Government grants, and that it has been entirely maintained by subsidies for the conveyance of the mails, is not supported by facts. Indeed, during the earlier portion of its career, the company, by agreeing to carry the Peninsular mails, shortly after it had been started, for a sum considerably less than the cost of maintaining the Admiralty packets then employed, with a speed, too, and regularity previously unknown, conferred an undoubted boon on the public. Steam Navigation Company.

Whether the company would have continued to maintain its career of prosperity without Government subsidies is a problem too speculative for me to solve; but it may well be questioned whether the grants of public money subsequently voted to it year by year, in so far as they prevented wholesome competition, and tended to damp the individual energy which brought it into existence, have been of much service towards its success. During one portion of the company's career, when the advantages of the overland route had been fully established, it might, and I think it would, have been to its advantage to have been relieved from every incumbrance as to time and speed. Free from these, and the many other conditions required by Government, the company would probably have done better for its shareholders had it been, also, at liberty to build and sail its ships as it pleased, despatching them on such voyages and at such rates of speed as paid it best; and, in support of this opinion, I may remark that various other shipping companies with no

assistance whatever from Government have yielded far larger dividends than the Peninsular and Oriental, and, further, that private shipowners, who never had a mail bag in their steamers, have realized large fortunes. With these remarks, I shall now endeavour to furnish a brief history of this important undertaking from its commencement, and to show that its rise was by slow degrees, and altogether unlike that of the Royal West India Mail Steam Packet Company, with which it has been frequently compared.

Its founders and origin.

In the year 1815, Mr. Brodie McGhee Willcox,[1] then a young man with no influence and but limited pecuniary means, opened an office in Lime Street, London, and commenced business on his own account as a shipbroker and commission agent. To assist him in his business he shortly afterwards engaged as clerk a youth from the Orkney Islands, Arthur Anderson,[2] subsequently his partner, whose only capital was a plain but sound education, good moral and Christain training, a clear head and great industry. In 1825, the firm adopted the title of Willcox and Anderson, and removed their offices to 5 St. Mary Axe, where they carried on their business till it was absorbed into that of the great

Messrs. Willcox and Anderson.

[1] Mr. Willcox was born at Ostend, but of English and Scotch parentage, his second Christian name, McGhee, being that of his maternal grandfather. He, however, spent his boyhood at Newcastle-on-Tyne, where he received the chief portion of his education. He represented the borough of Southampton for some years in Parliament, and died, 1862, at the age of 79.

[2] Mr. Anderson became member for his native borough, which he represented from 1846 to 1852. He took a great interest in developing the northern fisheries, and especially in forming a Shetland fishery Company, and in improving the condition of the people there. He died in 1868 at the age of 77.

company whose progress I am about to describe. Originally, it was simply a small shipping commission business, with the addition of the part-ownership of a few vessels chiefly trading with the Peninsula, with which they in time opened up, first a regular sailing, and then a steam line of communication, this service having been started solely by Mr. Willcox. At first, Messrs. Willcox and Anderson had a good deal of up-hill work, but they were plodding and industrious, and, consequently, overcame every difficulty, soon insuring that success which industry, honesty, and economy must ever command.

In 1834, the Dublin and London Steam Packet Company, one of the early undertakings of that description, of which Messrs. Bourne of Dublin, the well-known stage-coach contractors for the conveyance of the mails in Ireland, were the chief proprietors, chartered one of their vessels, the *Royal Tar* (see illustration, p. 380), to Don Pedro, and subsequently for the Queen Regent of Spain, through Messrs. Willcox and Anderson as brokers. Soon afterwards, M. Mendizabal, at that time Spanish Minister in London, induced Messrs. Bourne to put on a line of steamers between London and the Peninsula, for which Messrs. Willcox and Anderson were appointed agents. A small company having been thus formed to carry out this undertaking, Mr. James Allan,[1] a native of Aberdeen, then a clerk **Mr. James Allan.**

[1] When I commenced business in London, Mr. Allan was one of my earliest friends, and our friendship remained unbroken until his death in September 1874. I can therefore, of my own knowledge, speak of the difficulties he had to encounter, and of the numerous obstacles to be overcome in establishing the vast business with which he was so long and so intimately associated. To establish agencies at the leading ports

THE "ROYAL TAR."

in the office of the Dublin and London Steam Packet Company, was sent to London to assist Messrs. Willcox and Anderson in the management of the ships. He afterwards became secretary, and when the company had materially extended its operations, Mr. Allan, on the death of Mr. Carleton in 1848, was appointed a managing director in conjunction with Messrs. Willcox and Anderson.

How the Peninsular mails were originally conveyed.

Previously to September 1837, the Peninsular mails were conveyed by sailing post-office packets which left Falmouth for Lisbon every week, "wind and weather permitting." Their departures and arrivals, as must ever be the case with sailing-vessels, were very irregular, and it was no unfrequent occurrence for the mail from Lisbon to be three weeks old on its arrival at Falmouth. The mail communication with Cadiz and Gibraltar was, however, carried on by a Government steam-packet, and, though of course with greater regularity than the service performed by the sailing-packets, was, nevertheless, much slower than any of the steamers under the management of Messrs. Willcox and Anderson, who, feeling themselves in a position to effect considerable improvements in the transmission of the mails, submitted an offer to Government for a more regular

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of India and China, open depôts for coals, erect docks and factories for the repairs of their ships, to bring the whole into systematic and harmonious working order, and, above all, to keep agencies remote from each other and far from home, under proper control, required a master mind of no common order, the more so that the system he organized was then entirely new. Mr. Allan was, however, in every way equal to this arduous duty; his industry was unwearied, his love for truth ever conspicuous, and, with these he combined the most unassuming and pleasing manners. His only failing consisted in believing all other men to be as upright as himself.

transport of letters. But this proposal was coldly received, and their suggestions at first disregarded. Vested interests here, as in so many other cases, for a time prevented any improvement. The Peninsular Company, however, continued to prosecute their undertaking with vigour, the speed and regularity with which their steamers performed their passages soon attracting public attention. Loud complaints of the inefficiency of the transmission of the mails by sailing-packets at length arose, and, indeed, were so earnest and persistent on the part of the merchants engaged in the trade, that Government at last considered it expedient to inquire officially of the managers of the Peninsular steamers if they had any plan or proposals to submit for an improvement of the mail service, as, if they had, their views would now receive favourable consideration.

Proposal of Peninsular Company for their conveyance.

A fresh proposal was, consequently, made for a weekly mail between Falmouth, Vigo, Oporto, Lisbon, Cadiz, and Gibraltar, for which purpose efficient steam-vessels were to be supplied, to perform the service, monthly, between these ports, and at a lower rate than half the cost to the country of the steam and sailing-packets of the Admiralty.

Though Government now received the proposals of the company with favour and were prepared to act on the plan submitted for consideration, the company was informed that the service, nevertheless, must be put up to public competition. An advertisement was, accordingly, soon afterwards issued, inviting tenders from owners of steam-vessels for the conveyance of the mails between Falmouth and the Peninsula, in conformity with the plan submitted by

the Peninsular Company; so that the managers of this struggling undertaking had to compete against others for the due performance of this service, though on plans drawn up by themselves at the request and with the entire approval of Government. But though another company, which had a short time previously started under the name of the British and Foreign Steam Navigation Company, tendered for the conveyance of the mails, it was soon found that they were not able to carry out the service either within the time or on the conditions required. Time was, however, allowed them to perfect their arrangements, and, a month afterwards, fresh advertisements were issued by the Admiralty for the conveyance of these mails.

The British and Foreign Steam Navigation Company, however, having again failed to show that they had adequate means for the efficient performance of this service, Government entered into private negotiations with the Peninsular Company with the view of reducing the amount required by them, and, on the 29th of August, 1837, a contract was concluded by which this company agreed to convey, monthly, the whole of the Peninsular mails for 29,600*l.*, a sum subsequently reduced to 20,500*l.* per annum. The service was performed with much regularity, and it may be considered to have been the nucleus of the great company which now conveys the mails to all parts of the Eastern world. The *Iberia*, built by Messrs. Curling and Young, was the first steamer despatched with the Peninsular mails. She sailed in September 1837, the benefits thus conferred on those who were engaged in the

Contract concluded, Aug. 29th, 1837.

trade becoming at once apparent. Another step in advance soon followed.

Conveyance of mails to India previously to 1839.

The mode in which the mails were conveyed to and from India up to September 1840, was by means of steamers plying monthly between Bombay and Suez, and thence by Government steamers from Alexandria to Gibraltar, where they met the mails brought out by the Peninsular Company from England. As the steamers of this company had to call at Vigo, Oporto, Lisbon, and Cadiz in their passages to and from Gibraltar, and as the Government packets employed between that port, Malta, and Alexandria were of inferior power and speed, the transmission of mails by this route was necessarily slow, and generally occupied from three weeks to a month between England and Alexandria.[1]

But, however imperfect this mode of transmission, it would probably have continued for many years longer had not circumstances occurred rendering an alteration imperative. In 1839, the British Government having entered into a convention with the French Government for the sending of letters to and from India through France by way of Marseilles, an

[1] The mean rate of the sailing-packets on the average for a considerable number of voyages to the Mediterranean had been 2·7 miles per hour, the average length of the voyage from Falmouth to Malta, Corfu, and back to Falmouth being three months. The first of the Admiralty *steam*-packets, the *Meteor*, left Falmouth on this service 5th February, 1830, and she performed the round in about half the time of the sailing-packets. The *African*, *Carron*, *Columbia*, *Confiance*, *Echo*, *Firebrand*, *Hermes*, and *Messenger* followed and were regularly employed in this Mediterranean mail service. The average length of the voyages of steamers during a period of two and a half years to Corfu and back to Falmouth, was about forty-seven days including all stoppages—twice at Cadiz, Gibraltar, and Malta—which consumed about thirteen out of the forty-seven days engaged on the voyage.

Admiralty packet was stationed to ply between that port and Malta. Thence, these letters, together with the larger and heavier mails forwarded by the Peninsular and the Admiralty packets viâ Gibraltar, were conveyed from Malta to Alexandria by another of Her Majesty's ships.

That portion of the mails forwarded through France was despatched from the post-office on the fourth of every month, while the heavier portion continued to be sent from Falmouth every fourth Saturday by the Peninsular packets. As might have been expected, this plan was soon found to work awkwardly, inasmuch as the mail sent viâ Gibraltar every four weeks was in advance of that viâ Marseilles each calendar month, and had, therefore, to await at Malta the arrival of the Marseilles packet.

Irregularities such as these, increased as they were by each successive mail, together with the fact that the British despatches then ran some risk of loss in their transit through France, led Government to consider the advisability of establishing some quicker means of conveyance, viâ Gibraltar, for the main portion of the mails.

Government applies to the Peninsular Company.

The managers of the Peninsular Company having been again applied to, submitted for the approval of Government a proposal to establish a line of superior steamers to run direct from England to Alexandria, and *vice versâ*, touching only at Gibraltar and Malta; the steamers to be of sufficient power to perform this voyage in not more than three days beyond the time then occupied in the conveyance of the mails viâ France, and at a cost not exceeding what was required for the maintenance of the

small and inefficient Admiralty packets then similarly employed.

Their plan having met the approval of Government, public advertisements were again issued for tenders to carry it into effect, and no less than four competitors tendered for the contract at sums ranging from 34,200*l.* to 51,000*l.* per annum. As the tender of the Peninsular Company was not only the lowest, but contained, also, an offer to convey at a reduced rate all officers travelling on the public service, and *bonâ fide* Admiralty packages gratuitously, it was accepted by the Government.

and accept their proposals, though reluctantly.

The tender, however, was accepted with reluctance, various people of influence having, strange to say, almost convinced Government of the desirability of subsidizing a line of steam-vessels between Falmouth and Calcutta *viâ* the Cape of Good Hope, which was intended not merely to supersede to a great extent the sailing-vessels then employed, but to convey the Indian mails: indeed, it will be found by reference to the public journals of the period, that a steamer of then unusual size had been constructed specially for the purpose.[1] It was, however, wisely decided

Proposed direct line from Falmouth to Calcutta.

[1] "Scarcely has the wonder created in the world by the appearance of the *Great Western* and *British Queen*, begun to subside, when we are called upon to admire the rapid strides of enterprise by the notice of an iron steam-ship, the first of a line of steamers to ply between England and Calcutta, to be called *The Queen of the East*, 2618 tons, and 600 horse-power. This magnificent vessel is designed by Mr. W. D. Holmes, engineer to the Bengal Steam Committee, for a communication between England and India Great praise is due to Captain Barber, late of the Honourable East India Company's Service, the agent in London for the Steam Committee in Bengal, who has afforded every encouragement to Mr. Holmes in carrying forward his splendid undertaking. When these vessels are ready we understand the voyage between Falmouth and Calcutta will be made in thirty days." —*Times*, 11th November, 1838.

that no dependence could be placed on the due performance of the service within the "thirty days" stipulated; nor am I aware that the passage by the Cape of Good Hope, has yet been performed by vessels of any description in a space of time so limited.

First vessels hence on Indian postal service to Alexandria.

The vessels offered by Messrs. Willcox and Anderson and approved by the Admiralty, were the *Oriental* of 1600 tons and 450 horse-power, as also the *Great Liverpool* of 1540 tons and 464 horse-power, which, originally intended for the Transatlantic service, was now despatched with the mails from England to Alexandria, thus combining the two mail services, and constituting the Peninsular and *Oriental* Steam Navigation Company.

To complete the service, the directors were requested to provide a subsidiary vessel of not less than 250 horse-power, and another of 140 horse-power, for the Malta and Corfu branches, which they did at a cost of 10,712*l.* per annum less than the charge to the country for the Admiralty packets previously employed.[1]

Original postal service from Suez to Bombay.

Up to this period, as we have seen, the mails between Bombay and Suez were conveyed by steamers belonging to the East India Company. It soon, however, became apparent that these vessels were as unsuited to the Indian portion of the service, as those of the Admiralty had proved to be for that between Alexandria and England. But so reluctant were the Directors of the East India Company, to allow "interlopers" into their service, that some years still elapsed before their vessels were superseded

[1] See Evidence, Committee of House of Commons, 1840, question 1411.

by others of greater speed, and in all other respects more adapted to the increasing wants of the public.

Although the Home Government was so strongly impressed with the necessity of establishing a line of steamers between Calcutta and Suez, as well as from Bombay, it was only after considerable pressure had been brought to bear on the Court that the East India Company reluctantly consented to a contract with the Peninsular Company for this special service; and, on the 24th September, 1842, its new ship *Hindostan*, of 1800 tons and 520 horse-power, was sent from Southampton to open a line between Calcutta, Madras, Ceylon, and Suez.

Contract for mails between Suez and Calcutta, September 1842.

It may be desirable to state here that this originally small concern had, two years previously, been formed into a joint stock company with a charter of incorporation from the Crown, which enabled the directors to obtain the additional capital required for the Indian services; and, as they had now received the co-operation of most of those parties who, under the designation of the East India Steam Navigation Company, had been endeavouring to effect the same objects, they proceeded with all possible speed to fulfil the conditions and carry out the objects of their charter of incorporation.

Further proposals made by the East India Company and Government,

but finally rejected by the

Though the *Hindostan* proved vastly superior to the vessels of only 250 horse-power employed by the East India Company in the mail service between Bombay and Suez, which cost no less than 105,200*l.* per annum to maintain, the Court of Directors declined to listen to the further suggestions of the Home Government to transfer this branch of the postal service into the hands of any private undertaking and, indeed,

retained it until 1854. In the meantime Government entered into another contract with the Peninsular and Oriental Company for a monthly service from Ceylon to Penang, Singapore, and Hong Kong. For the service between Suez, Ceylon, Madras, and Calcutta, the company received 115,000*l.* per annum or at the rate of 20*s.* per mile, and, for the latter, 45,000*l.* per annum or about 12*s.* per mile.

East India Company.

Further contracts for mail service to China and Singapore.

When it became known that the Peninsular and Oriental Company had engaged to perform a service to India and the leading ports of China at the average rate of 17*s.* per mile in vessels of 500 horse-power, while the service between Suez and Bombay was costing upwards of 30*s.* per mile in vessels of not half that power, and, at the same time, of greatly inferior speed and accommodation, the public naturally demanded that the Bombay branch of the service should be placed in the hands of persons competent to carry it out more efficiently and economically than had been done by the East India Company.

But the Court of Directors successfully resisted all such demands until the Parliamentary Committee of 1851 reported that this service—in point of economy, the comfort of the passengers, and the requirements of trade—could be performed to greater advantage by private enterprise than by the vessels of the Indian navy. It is, however, questionable if the Directors would even then have given up the service had not the Bombay mails been, soon afterwards, lost in a native sailing-craft into which they had been transferred at Aden, the East India Company having no steamer ready to convey them thence to Suez. The Peninsular and Oriental Company having been applied

Peninsular and Oriental Company undertake the line between Bombay and Suez, 1854.

to, then found that, by means of the arrangements they had entered into for the performance of the other services, they could undertake this particular branch for the sum of 24,700*l.* per annum, or at the rate of 6*s.* 2*d.* per mile, thereby effecting a saving of about 80,000*l.* as compared with the expense incurred in the far less efficient service of the Indian navy.

In the meantime Government had, on the 6th January, 1848, given notice to the company to terminate their contract between Southampton and Alexandria on the 18th January of the following year, and, soon afterwards, advertised for tenders for the execution of this service. But, the other tenders being less advantageous to the public than the terms on which the Peninsular and Oriental Company was willing to continue the service, a new contract was entered into, for three years, at 24,000*l.* per annum or at the rate of 6*s.* 9*d.* per mile.

House of Commons Committee on Australian mail service, 1849.

Meantime also, the increasing trade with Australia created demands for greater facilities of intercourse with the mother-country and more regularity in conveyance of the mails, so that the Committee of the House of Commons, appointed in 1849 to inquire and report on the then existing system of mail communication with the East, was instructed also to consider the best mode of conveying the mails between India and our Australian colonies. In this Report, dated July 1851, these different services were divided into five distinct heads,[1] one of which, recommended

[1] 1st Line.—A line from England to Alexandria and back monthly, leaving England in the beginning of every month, and calling at Gibraltar and Malta, with a branch from Marseilles to Malta and back,

the establishment of a line between Singapore and Sydney. In reply to the advertisements issued on the recommendation of the Committee, two tenders were delivered on the 26th February, 1852, one by the Peninsular and Oriental Company for the whole of the services (their contracts of 1844 and 1849 being about to expire) with the addition of a branch line between Bombay and Point de Galle, not named in the conditions, for the annual sum of 199,600*l.*, to be reduced by 20,000*l.* per annum six months after the completion of the railway across the Isthmus of Suez; and the other, by the Eastern Steam Navigation Company, for a line once a month between England, Calcutta, and Hong Kong for the annual sum of 110,000*l.*, or for 100,000*l.* should Trieste be substituted for Marseilles as the port of embarkation, and

Eastern Steam Navigation Company and Peninsular and Oriental Company tender for it,

but the Peninsular and Oriental succeed.

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conveying between those two ports the mails which are carried across France.

2nd Line.—A similar line from England to Alexandria and back monthly, leaving England in the middle of every month, with a similar branch between Marseilles and Malta.

3rd Line.—A line from Suez to Calcutta and Hong Kong and back monthly. This line will take the mails which have left England in the beginning of each month, and will touch at Aden and Point de Galle, whence one steamer will proceed by Madras to Calcutta, and another by Penang to Singapore and Hong Kong.

4th Line.—A similar line from Suez to Calcutta and Hong Kong and back monthly, conveying the mails which have left England in the middle of the month, and proceeding in like manner to Point de Galle, and thence by Madras to Calcutta, and by Penang to Singapore and Hong Kong.

5th Line.—A line from Singapore to Sydney and back. Every alternate month a steamer to leave Singapore on the arrival of the outward packet at that port with the mails which have left England in the middle of every alternate month, and to leave Sydney so as to meet at Singapore the homeward packet, which will arrive there from China after the lapse of two months. These steamers are to touch both ways at Batavia, Swan River (or King George's Sound, as may hereafter be determined), Adelaide, and Port Phillip.

a further contract for the service between Singapore and Sydney on an annual subsidy of 166,000*l*. (which, however, was not mentioned in their tender), being 276,000*l*. for both services.

Although the tender of the Peninsular and Oriental Company was evidently much more favourable to the public interest than that of the Eastern Steam Navigation Company, the latter, nevertheless, petitioned Parliament to appoint another Committee to inquire into the whole subject, to which, however, the then Chancellor of the Exchequer declined to accede, at the same time furnishing (as appears from the Parliamentary debates) valid reasons for the course he considered it his duty to adopt.[1]

The *Himalaya* built.

Though a good deal of complaint was about this time raised against Government with regard to favours said to be conceded to the Peninsular and Oriental Company, yet they seem to have hitherto fought their way, step by step, against much opposition, and to have redeemed their character for speed, [which was somewhat overshadowed by the superior performances of the Cunard and Collins line of steamers, then in the midst of their great Transatlantic race], by the construction of the *Himalaya*,[2] a steamer of larger dimensions than any other then afloat, and of extraordinary speed.

[1] See "Hansard's Parliamentary Debates," May 28th, 1852.

[2] The *Himalaya* was 340 feet in length, 44½ feet width of beam, and her engines were 2050 indicated horse-power. She was 3540 tons O.M., and cost 132,000*l*. complete for sea. The company at the same time built the *Candia*, of 1898 tons, at a cost of 69,200*l*. and the *Nubia*, *Pera*, and *Colombo*, each of 1840 tons O.M.; also the *Simla* and *Bengal*, of 2417 tons and 2232 tons respectively, as well as the *Valetta* and *Vectis*. The whole cost of these vessels, added to their existing fleet, and destined to carry out the double service of a semi-monthly communication with the East, involved an outlay of 650,000*l*.

Nor did the Company receive any favour at the hands of Government when, about this period, they were seriously embarrassed for the want of a sufficient supply of coal[1] at their Eastern stations, and an appeal was made for a temporary relaxation of some portion of the service. Indeed, when the Company, on that account, found it impossible to carry on a portion of the second monthly service between India and China, the Government threatened to inflict the penalty of 35,000*l.* for its non-performance, and would have enforced the strict fulfilment of the conditions of the contract in all its details, had other arrangements not been made to meet the emergency.

New contract with Peninsular and Oriental Company, January 1853.

On the 1st January, 1853, the company entered into a fresh contract with Government, whereby they undertook to carry mails twice each way in every month between England and Alexandria, and twice each way in every month between Suez, Calcutta, and Hong Kong. Two vessels were also to be furnished to run between Marseilles and Malta, twice each way, in each month. The company further engaged to carry mails between Singapore and Sydney, once each way each alternate month. Tables of routes were attached and formed part of the contract. There were also certain stipulations as to proper machinery; a medical officer was to be placed on board each vessel, and provision was made for carrying pivot and broadside guns.

The vessels on the main line were required to attain a speed on trial of 12 knots an hour, the

[1] Shipping was so scarce that the average price of coal delivered at the different stations of the company rose from 36*s.* 8*d.* to 60*s.* 3*d.* per ton, and was with great difficulty obtained at even these exorbitant rates.

others $10\frac{1}{2}$ without the aid of sails, or they were not eligible for employment. The average speed of each vessel throughout the voyage was required to be not less than 10 knots an hour, excepting in the case of those between Singapore and Sydney, which were to make the passage at a rate not less than $8\frac{1}{2}$ knots. If the company failed to provide vessels ready to put to sea from any of the ports, viz., Southampton, Alexandria, Suez, Calcutta, Hong Kong, Singapore, and Sydney, at the time appointed, the forfeit in each case was stipulated to be 500*l.*, and a further sum of 500*l.* for every successive day up to the fourteenth day inclusive which might elapse before the vessel actually put to sea. And, if any vessel, in breach of the contract, delayed starting or put back or deviated, except from stress of weather, without the sanction of Government, the company was to forfeit 200*l.* and a further 200*l.* for every day's delay, unless from circumstances not under its control.

The Admiralty agent had power to survey the vessels, and the Admiralty itself, to compel such alterations as might be needed so as to keep pace with the advancement of science; while there were various provisions for the conveyance of naval, military, or civil officers, baggage, and victualing, as in other contracts.

In the event of accidents occurring to any of the vessels, the mails were to be conveyed by Her Majesty's or by the East India Company's ships: and an abatement made from the contract service money, at the rate of 6*s.* 2*d.* per nautical mile. For a consideration, the Admiralty reserved the privilege of changing the port in the channel, with the right

also of purchasing the vessels at a valuation; or of chartering them at a rate to be mutually agreed on or settled by arbitration. Any submission to be made a rule of court. In the possible case of an entire stoppage of the route through Egypt, the Admiralty were to act as the case might require; the whole postage remaining at the disposal of the Postmaster-General.

Failure of service during the Crimean War.

But these mail services were soon seriously disturbed. The urgent requirements of Government for the means of conveying troops to the Black Sea and the Baltic on the outbreak of the Crimean War, obliged the company towards the close of 1854 to discontinue the branch line to Australia, and to reduce the Bombay and China service to a monthly instead of a fortnightly line.[1]

The withdrawal of the company's steamers from the mail service between Singapore and Sydney, which had so recently been established, again created a large amount of discontent amongst the merchants in England connected with the trade and still more with the Colonists. The company was charged with selfish motives, and though obliged to relinquish the annual subsidy of 17,475*l.* for the performance of their service, it was alleged that the profits of the company, by the employment of its ships in the war, much more than compensated it for the reduction of the mail revenue. Thus considerable prejudice was raised against the company, and, in the discussion of the plans for the renewal of

[1] During the Crimean War this company had eleven of their steamers, measuring 18,000 tons, engaged in the transport service, which conveyed during the continuation of hostilities, 1800 officers, 60,000 men, and 15,000 horses.

the service after the war, it became clear that the colonists were anxious to have, if possible, a mail service of their own and altogether independent of the Peninsular and Oriental Company; hence, when the company offered to enter into a contract for the monthly conveyance of the mails between Ceylon and Sydney by steamers of an average speed of 10 knots an hour, touching at King George's Sound and Melbourne, at an annual subsidy of 84,000*l.*, the offer was peremptorily declined, though a greatly enhanced subsidy was subsequently paid, for the worst performed mail service that was ever undertaken.

Proposals for an independent Australian mail service.

In the meantime liberal grants of money having been voted by the legislative assemblies of the different colonies towards the maintenance of a postal communication with the mother-country, advertisements were issued by the Admiralty, in May 1856, inviting tenders for a "monthly direct and *independent* service" between Suez and Australia.

The conditions of tender contained many clauses of a novel character.

The ships to be employed were to be full power screw steam-vessels of not less than 2200 tons each; the tenders were to specify the maximum number of days to be consumed on the passages; and a "penalty of 100*l.* to be incurred when the contractors failed in providing a vessel, in accordance with agreement, ready to put to sea at the appointed hour; and also the sum of 100*l.* for every successive day which should elapse until such steam-vessel should actually proceed to sea; *and also (from whatever cause arising)* 50*l.* *for the first day, and a sum increasing by*

50l. per day for every succeeding day, that is to say, 50l. for the first day, 100l. for the second day, 150l. for the third day, and so on."

Four tenders were lodged in reply to this advertisement, but only two, that of the Peninsular and Oriental Company, and that of a new undertaking, the European and Australian Steam Navigation Company, were considered by the Government: the former offering to perform the service, provided the new and very onerous penalty clause was omitted, for 140,000*l.*; and the latter accepting all the clauses, but requiring 185,000*l.* per annum for the work to be performed, and stating that, should their tender be accepted, it was intended to lay on an independent line of steamers between England and Alexandria, and to perform the service between Suez and Melbourne in thirty-nine days outwards and thirty-five days homewards.

[illegible] Peninsular and Oriental Company "declined to be held responsible in penalties for failure as to the length of a voyage arising from causes *beyond their control*," and submitted that such penalties were unnecessary as the vessels they offered "had already been surveyed, and tested for an average speed of ten knots an hour at sea," the Government accepted the tender of the European and Australian Company.[1]

Tender of European and Australian Company accepted.

[1] About this time, the unfortunate mutiny in India naturally creating great anxiety that every possible means should be used to increase our communication with that country, combined with the rapidly increasing commercial intercourse, led to a modification and at the same time to the increase of the existing services. Hence, in November 1857, arrangements under the contract of 1854 were made to extend the line between Bombay and Aden to Suez and to establish, in connection with it, a fortnightly service between Marseilles and

So very large a concession as 185,000*l.* per annum for the work to be performed created at the time considerable surprise, and led to a good deal of discussion in the public press as well as in Parliament. With such an enormous subsidy the directors of the new undertaking would have had no difficulty in raising the requisite amount of capital in the open market for a service apparently so tempting, but they considered the margin for profit so ample that, instead of offering their shares to the public, they raised among themselves and their friends all the money that was considered necessary, anticipating no doubt a very handsome return upon the outlay.

Their entire failure.

But the whole undertaking proved one of the most ruinous of its kind on record, the Galway steam navigation scheme not excepted. A volume might be written, and to advantage, on the [illegible]stakes committed by the directors, all of whom [illegible]usiness men of wealth and position, though few [illegible]ad maconversant with maritime affairs, or wit[illegible]ties they had to encounter at every stag[illegible], [illegible] with the causes which ultimately led to the loss of some of their ships. Suffice it to say that, when the company had to commence operations in March 1857, its ships were not ready, and the directors were obliged to

Alexandria; the arrivals and departures of the Bombay mails being made to alternate with those of the Calcutta line, instead of being coincident with them as had previously been the case, so as to afford a weekly communication with India which has ever since been kept up. It was at the same time considered desirable to increase the voyages of the Marseilles packets, which were now running with the Calcutta and China mails, from Malta to Alexandria as their port of destination, for transit to Suez by means of the railway, which had by this time been opened across the isthmus.

enter into arrangements with the Royal Mail (West India) Steam Packet Company and other companies for the performance of the service; and indeed, when their own ships were ready, they either broke down or were found unfit to perform, within the specified time, the work they had undertaken.

In less than two years the whole capital of this new company was lost, but as the result has been fully described by Lord Overstone in a speech he delivered in the House of Lords on the 24th of March, 1859,[1] I prefer reproducing his statement, especially as it remains unquestioned, to offering any remarks of my own.

"This company," his Lordship remarked, "originated very much through the success of some influential parties in Glasgow, who realized a large sum by chartering two screw steamers to Government during the Crimean War. These vessels were named the *European* and the *Columbian*, and the company was named the 'European and Columbian Company.' Soon after the close of the Russian War, Government advertised for tenders for the Australian mail service. One given in by the European and Columbian Company was preferred to a cheaper one by the Peninsular and Oriental Company, the annual subsidy for carrying the mails being 185,000*l.* with monthly services, the contract to endure for five years. The penalty for the non-fulfilment of the contract was heavy, increasing prodigiously with each day's delay. In consequence of this great undertaking it was necessary to enlarge the company,

Speech of Lord Overstone, March 24th, 1859.

[1] See "Hansard" for March, 1859, and the *Times* of the 25th of that month.

and greatly to increase the number of its vessels; and, accordingly, a new company was formed on the limited principle, under the name of the 'European and Australian Royal Mail Company (Limited),' whom Government accepted for the contract. The nominal capital was 500,000*l.*, but I believe not more than 420,000*l.* were subscribed, the balance being purposely reserved, as the promoters expected it to command a large premium. The list of proprietors is one of the best I have seen of any company, all the shareholders, eighty-four in number, being selected men, residing chiefly in Glasgow and neighbourhood, London, Liverpool, and Manchester. 400,000*l.* were ultimately paid up. The first meeting of the new company was held on the 3rd of September, 1856; but it was, of course, some months before their plans got developed, and time was lost in negotiation with other companies to sell their contract for a bonus, or to get some other advantage. As this was not arranged, the *European* and *Columbian* were taken over from the old company; other vessels were chartered for immediate requirements; a vessel called the *Oneida*, by which 60,000*l.* were ultimately lost, was purchased; and two other vessels contracted for at 100,000*l.* and 120,000*l.* It was soon apparent that the company had started with too small a capital, and that there was a total want of experience in the management. . . . After borrowing considerable sums upon the security of their vessels and otherwise, the directors found that it was necessary to make arrangements with another company to work the service, which they ultimately did with the 'Royal Mail (West India) Company.'

An arrangement for an amalgamation of the two concerns was also very nearly completed, when the shareholders of the latter company refused to confirm the bargain made by the directors. This and the events of last autumn (1857) brought matters to a crisis, so that almost within a twelvemonth of the formation of the company, it was known that they were practically insolvent, and they have since placed themselves under the Act, and gone into voluntary liquidation. Besides the loss of 400,000*l.* of capital, the debts, including mortgages, appear to be about 270,000*l.*, against which they have the steamers, subject to some disputed claims of the Royal Mail Company, in whose hands some of them are. There is some hope that the steamers may realise sufficiently to pay the debts, but, in the present state of shipping and aspect of the questions with the Royal Mail Company, this seems to be doubtful. The following appear to be the heavier items of expense and loss: Abandoning steamers, 25,000*l.*; placing steamers on stations, 37,000*l.*; loss on voyages, 70,000*l.*; interest, management, and depreciation, 77,000*l.*; loss on *Oneida* and expense of bringing home, 61,000*l.*: total 270,000*l.*; but there will be a further heavy loss in realising the four steamers still belonging to the company, and the plant they have at Sydney, King George's Sound, Aden, and Point de Galle. These stand in the books at about 370,000*l.*"

When, in February 1858, the shareholders of this unfortunate undertaking were obliged to seek the protection of the Limited Liability Act under which it had been formed, the Royal Mail (West India) Company entered into arrangements with Government

Royal Mail Company

undertakes the Australian service and fails.

to carry out the service on the terms of the contract, provided it was guaranteed against loss to an extent not exceeding 6000*l.* per month. Differences, however, soon arose between this company and the Admiralty which resulted in a lawsuit, whereby it appeared that the West India Company had sustained a loss far in excess of 6000*l.* per month, and that the service had altogether cost the country close upon 260,000*l.* per annum during its brief existence.[1]

New tenders invited.

In September 1858, Government again advertised for tenders "for the monthly conveyance of the mails between Great Britain and the Australian Colonies, with a branch between Marseilles and Malta." Two offers were made, one by the Royal Mail (West India) Company for 250,000*l.* per annum, and the other by the Peninsular and Oriental Company for 180,000*l.*

That of Peninsular and Oriental Company accepted, 1859.

The latter was accepted, and the new service commenced in February 1859.

It may be desirable here to explain that this company had previously undertaken a monthly service between Mauritius and Aden for a subsidy of 24,000*l.* per annum, and, an arrangement having been made that the route for the Australian mails should be *vià* Mauritius, the performance of the mail service to both places was included in the 180,000*l.* But that route was soon afterwards abandoned, and a fresh agreement entered into between Government and the Peninsular and Oriental Company for a monthly line between Galle and Sydney, which, in conjunction with the Calcutta, Suez, and China lines,

Consolidation of services in

brought the Australian Colonies into direct communication not only with England, but also with India

[1] See report of proceedings, Court of Queen's Bench.

and China, and in fact with all the chief ports of the Indian seas. The subsidy for this service was 134,672*l.* per annum, the contract remaining in force until February 1866. The Peninsular and Oriental Company.

When fresh tenders were invited, the Peninsular and Oriental Company, having in this instance no competitor (though tenders were publicly invited), became again the contractors, agreeing to perform a monthly service for 120,000*l.* or a semi-monthly service for 170,000*l.* per annum, with boats which should attain a speed of 12 knots per hour on a measured mile, as a guarantee for an average speed of 10 knots per hour from port to port.

As there was a good deal of controversy about this time as to the average rate of speed of the vessels belonging to the principal mail companies, the table in the footnote[1] of the passages of steamers, for

[1] In the case of the Cunard line the average has been calculated upon a parliamentary return extending from January 1862 to April 1866, as is also the return of the average speed of the vessels of the Peninsular and Oriental Company during the same period.

CUNARD COMPANY.

Liverpool and Boston Line.	Knots.	Fath.
109 voyages outwards, average speed	9	2
112 „ homewards „	10	2
Liverpool and New York Line.		
109 voyages outwards, average speed	11	1
113 „ homewards „	11	7

PENINSULAR AND ORIENTAL STEAM NAVIGATION COMPANY.

	Knots.	Fath.
On the Australian Line	9	7
„ Calcutta and Suez Line	9	7
„ Bombay and Suez Line	9	2
„ Southampton and Alexandria and Marseilles and Alexandria Lines . .	10	0

The following averages are taken respectively from the reports

2 D 2

some years just previously to that period, belonging to the largest subsidized lines may be interesting and instructive.

Its present condition and fleet of ships.

From the thirty-fourth annual report of the Peninsular and Oriental Company, ending 30th of September, 1874, we learn that the paid-up capital amounted to 2,700,000*l.* and 800,000*l.* of debenture stock, also that it was the intention of the directors to call up in the course of the following year 10*l.* per share of their new stock, thus increasing the paid-up capital to 2,900,000*l.* apart from the debenture stock, so that the whole capital of the company would be 4,300,000*l.*, of which 600,000*l.* would remain unpaid. This large amount of capital is distributed over more than 2000 shareholders, resident in almost every part of the world, and of whom more than one-third are ladies. Of this capital 3,757,000*l.* consists of stock in ships; 221,000*l.* of freehold and leasehold property in England, and docks and premises at Calcutta, Bombay, Singapore, Hong Kong, and other stations; and 413,000*l.* in stock of coals and naval and victualing stores. Its fleet consists of fifty sea-going steamers, measuring 122,000 tons, and of 22,000 horse-power.[1] Of these steamers thirty-four are employed in the Mediterranean,

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published in 1865 of the British Royal Mail (West India) Company, and of the French Messageries Maritimes Company:

	Knots.	Fath.
Between Southampton and West Indies . . .	10	5
" " Brazils	9	5

The French Company give an average speed on their line to India of 9 knots 4 fathoms per hour for the years 1863 and 1864, but add "it is, for a general average, rather high."

[1] See Appendix No. 23, p. 639.

Adriatic, India, and China services; four in the Australian service between Ceylon, Melbourne, and Sydney; five in the China and Japan local services; two are used solely as cargo vessels; and five are either under repair or alterations, being reserved to supply the place of others in case of accidents. The company also possess twelve steam-tugs of from 31 tons and 15 horse-power to 271 tons and 120 horse-power, stationed for its use in Egypt, Aden, Bombay, Hong Kong, Shanghai, and Yokohama; and three cargo and coalhulks of 4417 tons, while it gives also permanent employment to 12,600 persons, exclusive of coal labourers and coolies on shore.

If my readers will cast their eyes on the map they will, by noting the ports at which these steamers call, form some idea of the extent and value of the services performed by this company. From England, crossing the Bay of Biscay along the shores of the Peninsula, to Gibraltar—the extreme limit of the original undertaking—its steamers now traverse the Mediterranean to Egypt, with a branch from Venice and Brindisi, and through the Canal to Suez, whence the most important line of steamers leave weekly for Bombay, with a further line from Bombay to Galle, and another direct from Suez to Galle, at which station the different lines diverge, one proceeding to Madras and Calcutta; another stretching far away across the Indian Ocean to King George's Sound, Melbourne, and Sydney; and a third crossing the Bay of Bengal and through the Straits of Malacca, calling at Singapore, and traversing the China seas to Hong Kong, and, thence, to Swatow, Amoy, Foo-chow-foo, and

Shanghai, stretching onwards to Yokohama, where the steamers of this line meet those of the Western world.

Terms of the contract now in force.

The principal conditions of the company's present mail contract, as compared with that of 1870, are as follows:—The company is now required to despatch steamers weekly to convey the mails from and to Southampton and the various ports in the East by way of the Suez Canal; the Brindisi, or accelerated mail, to be conveyed as heretofore to and from Alexandria and by railway across Egypt; the company to have the option of substituting either Liverpool or Plymouth for Southampton as their mail port; the arrival of the outward mails at Eastern ports to be accelerated by twenty-four hours, and the penalties for late deliveries at terminal points to be quadrupled and made absolute, except in case of shipwreck or damage to machinery. The subsidy payable for the performance of these and other services is to be reduced from 450,000*l.*, the sum agreed by the contract of 1870, to 430,000*l.* per annum, such sum to include the whole of the mail services rendered by the company.[1]

[1] The details of the different rates per mile which have hitherto been paid to the Peninsular and Oriental Company were as follows:—

	s.	*d.*	
The first India and China contract (1844 to 1853) was paid for at	17	1	per mile.
The second (1853 to 1866) was first taken at .	6	2	„
and was afterwards reduced to	5	5	„
The first portion of the Bombay service, namely, between Bombay and Aden, distance 79,872 miles per annum, was taken, in 1854, at .	6	2	„
The extension of this service to Suez increased			

It is not my province to inquire whether these services could not be performed for a smaller grant of public money than that now paid. Opinions differ widely on such matters, and, as the steamers now traversing every sea increase in numbers, the feeling becomes more general, that a considerable saving might be effected in the conveyance of all the ocean mails. But the vast establishment this company is obliged to maintain, and the all-important and onerous duties it has to perform, at stations far apart and many thousand miles distant from head-quarters, involves an outlay so great and embraces a risk so hazardous, that such a company may, on the other hand, well consider if the grant it receives, however large, is more than an equivalent for the services performed, especially, too, when we consider the stringent conditions of its contract.

Revenue and expenditure.

From whatever cause it may have arisen, the fact is apparent, that though the annual gross receipts of the company are enormous, its expenditure[1] is so

	s.	*d.*	
the distance to 142,656 miles per annum, and reduced the rate to	4	2	per mile.
And the subsequent arrangements in the Mediterranean brought the payment for the complete fortnightly line, now existing, down to the average of	2	7	„
The Australian service between Ceylon and Sydney was paid for, from 1861 to 1865, at . .	21	5	„
The same service was taken in 1865, at . . .	19	0	„
And the directors offered to double it for a sum that would reduce the rate to	13	6	„
India, China and Japan contract	6	7	„
Australian, Ceylon to Melbourne . .	14	4	„

[1] The following return gives the annual receipts and expenditure of the Company from 1856 to 1874 inclusive, by which it will be seen

great that less balance is left for the shareholders than is usually divided among those of undertakings of a similar character, which receive no assistance from Government, but are free to employ their ships in whatever branch of commerce they can be most profitably engaged.

Coals required.

Coal, as may be supposed, is one of the company's heaviest items of expenditure, and one, also, that has greatly increased during the last few years; but when the price was comparatively moderate, the accounts of this company, from 1856 to 1865 inclusive, showed an expenditure for coal alone of no less than 5,250,000*l.* sterling, or, on the average, 525,000*l.* per annum:

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that, while the revenue was less in 1874 than in 1860, the expenditure had increased, and that there was a deficiency in 1867 of no less than 177,047*l.*

	Revenue.	Expenditure.	Balance.
	£	£	£
1856	1,691,589	1,494,435	197,153
1857	1,877,420	1,645,748	231,772
1858	1,884,493	1,714,374	170,119
1859	2,176,590	2,006,363	170,227
1860	2,350,361	2,247,328	103,033
1861	2,288,289	2,131,432	156,857
1862	2,223,969	2,064,865	159,104
1863	2,296,305	2,060,849	235,454
1864	2,346,203	2,120,554	225,649
1865	2,136,076	1,976,999	159,077
1866	2,243,076	2,094,493	148,583*
1867	2,084,393	2,261,440	177,047
1868	2,485,965	2,313,817	172,148
1869	2,559,627	2,390,518	169,109
1870	2,317,016	2,174,672	142,344
1871	2,092,656	1,923,881	168,775
1872	2,122,756	1,953,551	169,205
1873	2,173,371	2,007,761	165,610
1874	2,186,663	2,047,899	138,764
	41,546,818	38,630,909	

* Deficiency.

moreover, a large stock must be constantly kept[1] to meet the demands of the steamers employed on their various lines of communication; to maintain this stock, the company employ 170 sailing-ships annually, a trade which, in itself, would have been considered of no mean importance in the days of our forefathers.

Description of vessels.

It has not been the least interesting portion of my labours, to describe the different modes of commercial intercourse with India from the dawn of history, and, from the scanty fragments of very ancient records, to attempt to afford information, however imperfect, of the ships of the first traders by sea to the far East, their dimensions, the routes they followed, the length of their voyages, and something about their crews and internal economy. I have also traced their progress, as best I could, through the period of the Roman Empire to the Middle Ages, when the vessels of the proud Italian republics, in connection with the Muhammedans, retained for centuries in their hands that rich and ever envied commerce, thence onward to the period when the Portuguese and the Dutch were masters of the Indian seas, and, still further, to our own days, when a company of traders ruled alike the land and ocean of these vast and much prized terri-

[1] About 90,000 tons of coal are usually kept in stock at their different coaling stations, distributed somewhat in the following proportions:

	Tons.		Tons.
Southampton	2,000	Calcutta	4,000
Malta	5,000	Singapore	8,000
Alexandria and Suez	6,000	Hong-Kong	10,000
Aden	20,900	Shanghai	6,000
Bombay	8,000	Yokohama	2,200
Point de Galle	12,000	King George's Sound	4,000
Madras	500	Sydney	1,200

tories; and I have, at the same time, given minute details of the ships and maritime services of this once all-powerful company.

Screw steamer *Khedive.*

I now supply the following illustration of one of the most modern vessels, belonging to the Peninsular and Oriental Company, engaged in that trade (she was built for the new line of commerce through the Suez Canal, by Messrs. Caird and Company, of Greenock, by whom her engines were also constructed); so that my readers may see the progress made in the mode of conducting maritime intercourse with India from the earliest period to our own time.

The *Khedive* is built of iron and propelled by the screw, combining all the qualities which modern science can suggest to secure with safety the greatest speed and capacity with the smallest current expenses.[1]

[1] The dimensions of the *Khedive* are as follows:—Length, 380 feet; breadth, 42 feet; depth, 36 feet. Her builders' measurement is 3329 tons; her gross register, 3742 tons; and her net register, 2092 tons. So far as regards capacity, she is fitted so as to accommodate with the space and style now required for Eastern travel (how different to the space allotted to passengers in the ships of Nearchus!) 164 first-class and 53 second-class passengers. Besides this, she has store-rooms of various kinds to hold 380 tons, rooms for mails and baggage to contain 142 tons; bunkers to hold 846 tons of coals calculated at 45 cubic feet per ton, and holds which can receive 2003 tons of cargo of 50 feet to the ton.

Her *average* speed is 10 knots per hour on a consumption of 32 tons of coal per diem, but "she can be driven at a much higher speed with a proportionate increase of expenditure of fuel." The contract specifies a speed to be guaranteed on trial of not less than 13½ knots an hour on the measured mile, with dead weight on board of coals or cargo to the extent of 1500 tons.

Her engines are compound, "vertical direct acting," of 600 nominal horse-power, with 4 feet 6 inches length of stroke. The diameter of her cylinders is 69 and 96 inches respectively, and that of her screw, which consists of four blades, 17 feet 6 inches; its pitch being 22 feet 6 inches and 24 feet. She has 4 boilers and 16 furnaces. The

THE PENINSULAR AND ORIENTAL COMPANY'S STEAMER "KHEDIVE."

It would weary my readers were I to furnish a specification of the hull and outfit of the *Khedive*, more especially as somewhat similar specifications are to be found in numerous treatises on modern ship-building, with which I do not profess to deal, and as it would, in itself, occupy forty or fifty pages of this volume. It may be sufficient to state, in the concluding words of the contract, "that the whole of the materials and workmanship are to be of the best quality, and the vessel, with the exception of bed and sofa mattresses, curtains, plate, cutlery, glass, china, linen, and bedding, to be entirely fitted and ready for sea at the cost of the contractors;" the contract price for the ship thus fitted complete for sea, including her machinery, was 110,000*l.*, or a little more than 33*l.* per ton builders' measurement.

Of course the price of all ships, as previously stated, depends on their class, power, and equipment, so that the cost of one vessel ready for sea may be very different from that of another ship. For instance, sailing-ships, when new, range from 8*l.* to 22*l.* per ton, and steamers from 15*l.* to as high as 40*l.* or even 45*l.* per ton if the engines be very powerful, highly finished, and mounted, and if the passenger accommodation be of an unusually superior and extravagant description.

In comparing this ship with the illustrations I have given of vessels of even comparatively modern times, my readers will be struck with the difference. Instead of the great hull towering high out of the

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fire-bar surface is 320 square feet, and the heating and condensing surface 11,720, and 6059 square feet respectively. The loaded pressure is 55 pounds on her boilers.

water, with poops and top-gallant forecastles resembling the towers or castles on shore from which they derive their name, we have the long, low, yacht-looking craft offering the least possible resistance to the winds and waves against which she has to contend, yet affording more safety, as experience has shown, and far more comfort, with vastly increased capacity, in proportion to her register, for cargo and passengers, than the ships of any nation of any previous age.

Particulars of this ship.

In other respects it would be useless to attempt a comparison. We have nothing in ancient times to compare with the steam-ship, unless it be the row-galley, and to propel a vessel of the size and weight of the *Khedive* at the rate of four miles an hour through the smoothest water would require at least 2000 rowers. I may however state, for the information of my readers, that the *Khedive* will perform the voyage from Southampton to Bombay in thirty days (an abstract from her log will be found, Appendix No. 22, pp. 637–8), or in one-third of the time which Dr. Vincent, when he wrote at the commencement of this century on the commerce of the East, considered extraordinarily short between Bombay and England; indeed, is short, too, for a sailing-vessel of even our own times. A list of her crew, arranged according to their different departments, is furnished herewith.[1]

1

		Europeans.	Natives
Navigating	Commander	1	
	Officers	5	
	Surgeon	1	
	Carpenter	1	
	Boatswain	1	
	Quartermasters	3	

Uniform and regulations of the company.

Following the example of the old East India Company, the directors of the Peninsular and Oriental Company, as well as of many other similar undertakings, require their officers to wear uniform. They also issue regulations for the guidance of the engineers and for the general management of their ships (especially with reference to safety and economy). These regulations are similar in many respects to those of other companies, though not so complete as those of the Cunard, nor, we fear, from various accidents which have occurred, so rigidly enforced. Upon this all-important point—the *safety of the ship*—it would be impossible to impress too strongly upon shipowners the duty they owe to the public, since, by the vigorous enforcement of such regulations, numerous valuable lives might be saved and many terrible calamities prevented. To uniforms I have no objection, but such matters are of very secondary consideration to the safety of the vessel, and while holding the opinion that polite and well-

		Europeans.	Natives.
	Brought forward	12	
Navigating	Carpenter's mate (Chinese)		1
	Gig's crew (do.)		6
	Seamen (Lascars)		43
	Assistants of different sorts		6
Engines	Engineers	6	
	Coal trimmers, &c.		49
Cabins	Purser	1	
	Clerk, Head Steward, Cook, Baker, Butcher, Pantryman, Storekeeper, and Barman	8	
	Stewards	22	
	Stewardesses	2	
	Purser's department		21
	Total Europeans	51	Natives 126

dressed officers are an acquisition, especially to a passenger ship, their acts of courtesy must never be permitted to interfere in the slightest degree with their paramount duties as seamen, which require them, considering the varied and increasing dangers to which steam navigation is exposed, *to be ever on the alert.*

I have ventured to offer these few concluding remarks because some of the losses of the vessels of the Peninsular and Oriental Company, which occurred in fine weather and in smooth water, might have been avoided. The directors have, however, since then issued (March 14th, 1874) to the commanders of their ships more stringent instructions, and have intimated that any neglect of duty, especially as regards "lookouts," will be "severely visited."[1]

[1] For fleet of Peninsular and Oriental Steam Navigation Company, Jan. 1875, see Appendix No. 23, pp. 639-40.

CHAPTER XI.

Changes produced by the opening of the Suez Canal—Sailing fruit-clippers—Introduction of steamers into the Mediterranean trade, 1840—Establishment of various steam lines, 1850—That of Messrs. Frederick Leyland and Co., &c.—Their fleets—Messageries Maritimes Company—Its origin and management—First contract for the conveyance of the oversea French mails, 1851—Extension of contracts, 1854–56—Brazil line, 1857—Vast extent of its fleet—Largest vessels—Trade viâ the Suez Canal—Presumed advantage of auxiliary engines—Not borne out by the results—Conveyance of the Australian mails—Peculiar conditions of contracts—Failure of the service—Stringent penalties—Australian steam services—Mr. Alfred Holt's line of steamers to China—Its success—Messrs. Gellatly, Hankey, and Company—Messrs. Green and Company—Messrs. Rathbone Brothers—Messrs. George Smith and Sons—Letter from Mr. George Smith—Messrs. Smiths' ships and their voyages to and from India—Changes in the mode of conducting commerce with India and China—Number of vessels through Suez Canal since its opening, and their nationality.

Changes produced by the opening of the Suez Canal.

NOT the least interesting of the many changes in maritime commerce brought about by the opening of the Suez Canal, has been the restoration, though as yet to a limited extent, of the earliest commercial intercourse recorded in history between the Mediterranean and the once far East, and of the trade the merchants of the Levant and the Adriatic carried on with India by the agency of the Muhammedans in Egypt during the Middle Ages.

Directed to a different route by the re-discovery of the passage to the Eastern world by way of the Cape of Good Hope, this ever envied trade has, since

the close of the fifteenth century, been conducted as we have seen from the Atlantic and northern ports of Europe, and during more recent years, from those of Great Britain. Consequently, the vessels belonging to the Mediterranean ports have been obliged to seek other and much less remunerative employment, which, since the decline of the great Italian Republics, has dwindled into comparative insignificance. Nor has the Mediterranean trade itself occupied a position of any importance during the last three centuries, indeed it has only revived since steam-vessels have given new life to those inland seas, which, throughout all time, have been so familiar to the mariner. It has been, hence, confined chiefly to that carried on between the inhabitants of the different countries bordering on the shores of the Mediterranean and Black Seas, who, having little or no encouragement to export their surplus produce to other nations, never thought of employing vessels of a superior class to those which for ages had sufficed for their coasting trades.

The first measure, which gave renewed existence to the maritime commerce of these peoples, was the repeal of the British corn laws, encouraging, as this did to an extent hitherto unknown, the importation of wheat from the ever luxuriant lands of Egypt, and from the numerous corn-growing countries bordering the shores of the Black Sea, the Marmora, and the steppes of Russia. Soon afterwards, the repeal of the duties on the fruits grown in such rich abundance in the islands of the Levant and along the coasts of the Mediterranean, gave new life to another branch of trade which had long lain dormant, and, while the former afforded greatly increased employment to the ships of all nations, the latter

Sailing fruit-clippers.

encouraged the production of vessels so superior to those previously in use, as, in speed, to outrival the once celebrated Baltimore clippers.

Introduction of steamers into the Mediterranean trade, 1840.

Curiously enough, however, the introduction of these fast fruit schooners, seldom exceeding in size 200 tons register, retarded the introduction of steamers to the trade of the Mediterranean till a much later period than would otherwise have been the case, considering their early and rapid extension in all other branches of commerce. Growers and merchants engaged in the fruit trade, as was the case with the shippers of tea from China at a still later period, were under the impression that steam would injure the flavour of their fruits; hence, for a time, declined to ship their produce in vessels propelled otherwise than by sails. They likewise preferred to export their raisins, figs, and currants in small quantities, convinced that they would thus obtain higher prices and a readier market, and consequently engaged vessels of 80 and 100 tons rather than those of greater dimensions. Many of my readers cannot fail to recollect the fleets of beautiful small Mediterranean clippers which were wont to crowd our docks at certain seasons of the year. Moreover, as these vessels made their voyages with extraordinary rapidity and regularity, the inducements to employ vessels propelled by steam were less urgent than in most other branches of trade.

Although steamers occasionally visited the Mediterranean, it was not till 1840 that any attempt was made to establish a line or succession of voyages in the trade with Great Britain, much less among the islands of the Levant, and along the shores of the Black Sea and the Adriatic. Among the earliest

attempts may be mentioned that of the *Rattler*, of 350 tons and 50 horse-power, despatched by Messrs. Vivian, Jones, and Chapple, of Liverpool. About 1840 the Peninsular Company also extended the operations of their steamers to Malta and Alexandria, and soon afterwards to Corfu, the Levant, and Constantinople. In 1845 Mr. A. Mongredian, of Liverpool, attempted to establish a regular line between that port and the Levant with the steamers *Osmanli* and *Levantine*, but being unsuccessful, they were transferred in 1849 to Messrs McKean, McLarty, and Lamont, who employed them between Liverpool, Marseilles, Genoa, Leghorn, Naples, Messina, Palermo, and the Adriatic, where they appear to have yielded more remunerative returns.

Establishment of various steam lines, 1850.

From about this period, steam in those trades, as it has done everywhere else, made its way when fairly established; and, afterwards, increased with extraordinary rapidity, affording greatly improved facilities for the development of ancient branches of maritime commerce, which had long lain dormant, as well as for the creation of others hitherto unknown. Various associations and companies were now formed to carry on the trade of those inland seas by means of steam-vessels from both London and Liverpool. Among the most important belonging to Great Britain, were the lines of steamers sent forth by Messrs. Bibby, Sons, and Company, now Messrs. Frederick Leyland and Company, and by Messrs. Burns and McIver; while the Austrian Lloyd's Steam Navigation Company trading from Trieste, and the French Messageries Maritimes from Marseilles, were the chief foreign undertakings established to carry on the coasting trade in which the protective character of

That of Messrs Frederick Leyland and Co., &c.

the Austrian and French navigation laws conferred on them exclusive privileges.

In the trade from Liverpool, including the Peninsular service, Messrs. Frederick Leyland and Company alone now employ no less than twenty-three large iron steamers, seventeen of them varying in size from 1500 to 3000 tons gross register, bound direct to the Mediterranean ports. These are all propelled by the screw, and are surprising specimens of purely cargo steamers. In this respect, considering their capacity in proportion to their admeasurement, tonnage, and small current expenses, these vessels are, perhaps, unsurpassed by any steam-ships afloat. For instance, the *Bavarian*, of which an illustration may be seen on the previous page, takes 4800 tons of cargo exclusive of her coal bunkers, though of only 3052 tons gross register, and is navigated by the comparatively small number of forty-eight persons all told.[1] The steamers of this firm and of Messrs. Burns and McIver, as well as those of various other companies, now run in regular lines from London, Liverpool, and elsewhere, to the numerous ports of the Mediterranean, Levant, Adriatic, and Black Sea. Their fleets.

Gibbon, in his brilliant description of the Decline and Fall of the Roman Empire, speaks of the terror of its Senators lest the supply of corn should fail in meeting the requirements of the once all-powerful capital, and create, as usual, violent tumults among the people; but, with the fleet alone of Messrs. Leyland

[1] Besides the *Bavarian*, Messrs. Leyland employ in this trade the *Bohemian* and *Bulgarian*, similar in all respects, each of which is 400 feet in length, 37 feet wide, and 28 feet in depth, with engines of 350 nominal horse-power. They have also in the same trade other three sister ships, the *Iberian*, *Illyrian*, and *Istrian*, each 2890 tons gross register and carrying 4400 tons of cargo, dimensions 390 × 37 × 29.

and Company at their command, all apprehension on this score would have vanished, as either of the three vessels I have mentioned could, with the present appliances for loading and discharge, have transported from Egypt to Rome in the course of twelve months, no less than 500,000 quarters, or 4,000,000 bushels, while the whole fleet could have taken 10,000,000 quarters, had Egypt been able to produce within the year that quantity of grain. Such are a few of the changes the application of the motive power of steam has produced within our own time.

Messageries Maritimes Company.

But much the largest maritime undertaking engaged in the trade of the Mediterranean and elsewhere, is that of the Messageries Maritimes, recently the Messageries Imperiales, monopolizing, as this does, nearly the whole of the steam tonnage of France. Indeed, apart from the vessels owned by this association, and one or two other highly subsidized shipping companies in that country, the French may be said to have no steamers.[1] Their protective policy, combined with the depressing influence which large grants of public money to special undertakings must ever exercise on individual energy, has effectually overpowered all private enterprise of this description. It may be true, as has been frequently alleged, that the French people have no natural aptitude for maritime pursuits, and that their children, who are not employed in their vineyards, or in the manufacture of those special articles for which they have long been celebrated, take naturally to the fife and the drum with somewhat of the same avidity that the boys of England seek enjoyment in navigation;

[1] The whole steam tonnage of France amounted in 1873 to 185,165 tons net register.

but, certain it is that, owing to restrictive laws and enormous subsidies to favoured individuals, the French people, generally, have never yet been allowed the opportunity of showing what they could do in the peaceful paths of maritime commerce.

The Messageries Maritimes, their greatest shipping undertaking, though exceedingly well managed, is after all, a pure creation of the Government—one, too, nursed with the greatest care from its infancy, and maintained throughout by large grants from the public purse, which were materially increased on the accession of the third Napoleon to the Throne of France, who, throughout the whole of his reign, displayed a marked anxiety to promote and encourage maritime undertakings. Previously, indeed, to 1851, the company had been chiefly engaged as carriers by land, and was under contract for the conveyance of the mails throughout a considerable portion of France. Its origin and management.

In July of that year this company entered upon its first oversea contract with Government for the conveyance of the French Mails to Italy, the Levant, Greece, Egypt, and Syria, and in 1852 spontaneously added to their services the principal ports of Greece and Salonica.[1] First contract for the conveyance of the oversea French mails, 1851.

In 1854, the managers of the Messageries Company concluded arrangements with the Minister of War for the transport of all troops and military stores between France and Algeria, besides the conveyance of the mails, and, having very materially increased their fleet owing to the requirements of the Crimean campaign, they were, in 1855, enabled to open between Extension of contracts, 1854–56.

[1] The Greeks, strange to say, considering their shrewdness and keen business habits, stopped the coasting trade of foreigners, thereby doing incalculable injury to their own commerce, not having capital themselves to supply the deficiency or perform adequately the service.

Marseilles, Civita Vecchia, and Naples, a direct weekly line of steamers, independently of the postal service, principally intended to meet the requirements necessary to be maintained between the War Department and the army of occupation at Rome.

When the Crimean War happily came to a close, and the military lines of steamers to the Black Sea were no longer necessary, the directors, in 1856, employed their disposable vessels in increasing the frequency of services to Algeria, and in establishing a postal service between Marseilles and the ports of the Danube and along the east coast of the Black Sea, for which they obtained a contract from Government in 1857. In that year they, likewise, entered into arrangements for the conveyance of the French mails between Bordeaux, the Brazils, and La Plata.

Brazil line, 1857.

Vast extent of its fleet.

The fleet of the Messageries Company had now reached fifty-four ships of 80,875 tons, and 15,240 horse-power, afloat or in course of construction, evidently more than they could profitably employ: they, therefore, applied for and obtained from their Government, in 1861, a contract for the conveyance of the French mails to India and China, requiring for this purpose only an additional steamer. But the increase of trade to the East, brought about in no small degree by the increased facilities and by an anxious desire on the part of the company to meet the wants of the travellers of all nations, very soon enabled the directors to double the services of their steamers to the East. In 1871 their fleet measuring 137,334 tons, of 20,885 horse-power, performed services on the India and China routes of 230,135 French leagues; on the Mediterranean and Black Sea, 153,478; and, on the Brazilian, 50,004: in

all, 423,607 leagues annually, independently of various extra services. Since then their Brazilian and La Plata lines have been doubled, and now (1875) the company employs 175,000 tons of steam-ships, besides chartering numerous sailing-vessels.[1]

When first the Messageries Company became carriers by sea, they had nearly all their vessels built in England, but they now possess large establishments of their own, where they construct screw-steamers of iron, rivalling in most respects, and very much resembling those of, the Peninsular and Oriental Steam Navigation Company, of which I have furnished an illustration.

Their two largest ships employed in the trade with India and China are the *Anadyr* and the *Irawaddy*, of 3671 and 3471 tons gross register respectively, and each of 600 nominal horse-power. The other sixteen vessels in that service range from 3017 tons and 500 horse-power, down to 1035 tons and 280 horse-power. Their six steamers employed on the Brazilian and River Plate line are from 3417 tons and 600 horse-power, to 2115 tons and 400 horse-power, while the thirty-five engaged in the Mediterranean and Black Sea services range from 2524 tons and 500 horse-power to 430 tons and 160 horse-power. They have also three steamers of 1500 tons and 250 horse-power engines on the compound principle trading between London and Marseilles, and Largest vessels.

[1] My readers will perceive that this company apparently owns within 10,000 tons of the whole of the steam-shipping of France, but this arises from the gross tonnage being given in the former returns, and only the net registered tons in the latter. Nevertheless, the Messageries Maritimes is now the largest steam-ship company in the world. A list of the steamers of this company, and how employed, will be found in the Appendix No. 24, p. 641.

four magnificent screw-steamers in course of construction, each of 4000 tons and 600 horse-power.

The trade of this large Company now embraces all the chief ports of the Mediterranean and Black Sea, and those of India, China, Java, and Japan, as well as of Algeria and the Brazils; and the excellent manner in which the different lines are conducted and navigated by Frenchmen is the best answer that can be given to the old saying that the French never were and never will be a maritime people. That they do not equal the English on the ocean is likely enough, nevertheless that they would become much greater as shipowners than they now are there can be little doubt, were they governed by wise laws and left to depend upon their own energy and resources rather than on government grants. Throughout all time "protective" laws seem to have retarded the natural development of commerce, as they have been too frequently the ruin of nations as well as of individuals.

Trade viâ the Suez Canal.

The ships of the Messageries Maritimes Company, like those of their great competitors for the trade of the East, the Peninsular and Oriental Company, now pass through the Suez Canal. But, besides these two companies, the former of which receives nearly double the amount of subsidy of the other,[1] there are now numerous other steam lines following the same route, all bidding for the ever envied trade of the once mysterious Cathay; and these have increased enormously since the waters of the Red Sea, passing through the desert, mingled with those of the Mediterranean.

[1] The Peninsular and Oriental Steam Navigation Company for a service of 1,171,092 miles, receives 430,000*l*., while the Messageries Maritimes is paid at present (June 1875) 399,838*l*. for a service of 631,514 miles.

Hitherto steam to India by the way of the Cape of Good Hope has proved an unprofitable undertaking: nor, with all the improvements tending towards increased economy on the one hand, and greater capacity for cargo on the other, does it offer many more inducements now, than it did when the *Enterprize* first found her way to Calcutta.

Nor, indeed, has any better success attended steam navigation undertakings to the distant colonies of Australia. From the time that the trade with India was thrown open, sailing-ships thither, as well as to Australia, have been the chief means of transport, and these still carry by far the largest proportion of the goods traffic, though first-class passengers prefer the more expeditious overland routes: but steam-boats, even though largely subsidized, especially to India by the way of the Cape, have found it impossible to compete successfully with the sailing-ships of Messrs. Green of Blackwall, Messrs T. and W. Smith, and other private shipowners long engaged in the trade.

The two steam companies, formed nearly simultaneously about the year 1852 to run viâ the Cape of Good Hope: one, the General Screw Steam Company to Calcutta and intermediate Indian ports; and the other, the Australian Royal Mail Steam Company, though each received large grants of public money, alike proved signal failures. Nor can the failure of these undertakings be altogether attributed to mismanagement. A good deal of it was, doubtless, due to the description of vessels employed, and to their unsuitability for the services undertaken, but still more to the fact that neither auxiliary steam-ships, nor full-powered steamers, have hitherto been profitable on distant voyages.

Presumed advantage of auxiliary engines.

About that period many shipowners were under the impression that full-rigged ships, such as the *Massachusetts*, with an auxiliary steam-engine, to be used only in calms and light winds, would in themselves combine all the best qualities of a sailing-ship and steamer: nor was this surprising. On the voyage, for instance, from England to India a sailing-vessel during the favourable trade winds and monsoons, which can always be depended upon for a considerable part of the voyage, would, under sail alone, make almost as much progress as a steamer; while, in the calms, which are invariably met with for from five to ten degrees on each side of the Equator, and, where sailing-vessels frequently are long detained, the small steam-engine could be applied to great advantage; as also on entering as well as on leaving harbours. Indeed, so strongly impressed was I with the value of auxiliary steam-vessels for distant voyages, that, in 1856, I undertook, even after these failures, to convey in seven such steamers, three-fourths of which belonged to myself, the monthly mails, within a given time, between London, the Cape of Good Hope, Mauritius, Ceylon, Madras, and Calcutta.

The vessels thus employed were built entirely of iron, and ship-rigged, as may be seen by the following illustration of one of them; more fully so, in proportion to their size, than those of the General Screw Company, and, as their engines were only from 80 to 120 horse-power nominal, on a tonnage of from 800 to 1500 tons gross, they were purely auxiliary vessels. Under sail their speed was from 10 to 11 knots, with a favourable wind, and, under steam alone, from 6 to 7 knots an hour in light breezes

or calms, but, in adverse winds, they made little or no progress, a fact arising in great measure from their small steam-power and from the resistance their heavy spars presented to the winds: consequently, though they met with no accidents, and were more to be depended upon, as to time, than ordinary sailing-vessels, they could not maintain the regularity essential for the mail service; so, after twelve months' experience, I relinquished the undertaking.

Since that time no mails have been carried in any description of steam-vessels from England to ports eastward of the Cape of Good Hope by the Atlantic

sea route, except it may be to Natal, and occasionally to the Mauritius, or to Zanzibar on the east coast of Africa.

In full powered steamers the space required for coals and machinery on these distant oversea voyages, over and above their first cost and current expenses, prevent them carrying cargo sufficient to afford

Not borne out by the results.

remunerative returns, and their owners are not recouped by the extra rates of freight obtainable for the time saved on the voyages. In the case of the auxiliary steamers the results are the same, arising in a great measure from similar causes, for, though such vessels had greater space for cargo, yet the advantage thus gained is counterbalanced by the maintenance of a staff of engineers and firemen who, during the greater portion of the voyage are unemployed, and by the fact already stated that, though the auxiliary engine is valuable in calms, it has not power enough to be of service against strong and adverse winds. As a rule, therefore, it is in most cases more profitable to employ either a steamer with only light spars and a few fore and aft sails, or a full-rigged vessel which depends entirely upon her sails. Anything between the two has not hitherto been found to answer so well, though there may be exceptions depending on the trade in which such vessels are employed.

Conveyance of the Australian mails. From the time of the opening of the overland route, all the mails to the East Indies have passed through Egypt, except those despatched by the two lines of auxiliary steamers round the Cape of Good Hope, to which I have just referred; and even by these vessels few or no letters were sent except to the intermediate ports; but, for many years after the overland route had been opened, the British mails to Australia and New Zealand were conveyed almost entirely by sailing-vessels, except during the two or three years the Australian Royal Mail Steam Packet Company carried on its operations. When the steamers of that company were unable any longer to continue the service, the Peninsular and

Oriental Company undertook, as we have seen, the conveyance of these, the more important mails by way of Ceylon; but, when the service was relinquished for a time, as some of their steamers were required as transports for the Crimean War, the conveyance of the whole of the Australian mails, greatly to the annoyance and discomfort of the colonists, reverted again to sailing-vessels.

To obviate as far as practicable the delay and uncertainty in the time of the delivery of the letters, Government, instead of contracting for their conveyance by any one line of sailing-vessels, considered it expedient to throw the contracts open to the competition of all suitable vessels engaged in the trade with Australia. But this, too, was merely an experiment, and one which proved alike unsatisfactory to the public and Government. It was tried, however, for a year or more and, as it so happened, the trial was made just between the time when the steamers of the General Screw Company and those of the Australian Royal Mail Company had ceased to run, and of my own experiment with the Cape and Indian mail services.

Peculiar conditions of contracts.

To insure speed and, if possible, regularity, the Post Office authorities stipulated that from the amount to be paid to each ship thus employed, there should be deducted a penalty of 20*l.* for every day's delay in the delivery of the letters beyond the time specified in the tender. Instead of leaving the sum, as had hitherto been and now is the invariable practice, to be named by the person who tendered, Government fixed it at 1000*l.* for the passage, accepting the offer which contained the fewest number of days for the performance of the service. Thus, a

shipowner who could reckon with tolerable certainty, that his vessel would make the voyage to Australia in 100 days, which most first-class ships could do, might safely tender to do it in, say, seventy-seven days, because after the deduction of the 20*l.* per day for the twenty-three days in excess, he would have a balance of 540*l.* to receive (besides other advantages which "mail-packets" derived), and as that sum would further cover an additional excess of twenty-seven days, or say altogether fifty days beyond the time contracted for, the speculation was an exceedingly safe one to a sailing-ship, even if the tender were made for the shortest time in which the fastest steamer had been known to accomplish the voyage. Hence this system of tender proved altogether illusory as regarded the securing a rapid communication. The very first ship, the *Stratford*, despatched under the new arrangement, occupied on her outward passage a period of thirty-seven days in excess of the time stipulated!

Failure of the service.

If the colonists had been loud in their previous complaints they were still more so now; but the Treasury and Post Office authorities, considering that they had done their best to secure speed, were, for a time, immovable and indisposed to make any further experiments. Steamers and sailing-vessels on so distant a voyage having alike failed, Government thought there was now a good answer to all complaints, and, consequently, treated them with indifference. They argued, referring to the then recent failure of the Australian Royal Mail Packet Company, that, as the steam-vessels between England and Sydney had varied from seventy-six to 120 days, while the length of passage by fast sailing-ships

between England and Port Phillip was from eighty-two to 110 days, the difference was not really of any serious disadvantage. Nevertheless, while Government refused increased grants for the conveyance of the mails, it adopted and enforced much more rigorous penalties[1] against owners of sailing-ships to ensure a more speedy performance of the mail services. This fresh experiment, however, from its extreme rigour also failed, and some time elapsed before the colonists obtained what they had long demanded, a direct and *independent* line of steam-vessels by way of Suez and Ceylon; and that, as we have seen, proved in the hands of the European and Australian Steam Navigation Company the most signal failure of all the experiments which had been made.

Stringent penalties.

[1] An amusing incident occurred at this time to myself not altogether unworthy of notice. When the discussions were going on about the irregularity of the sailing-ship mails, the late Mr. James Wilson, then Secretary to the Treasury, one day asked me how these irregularities could best be remedied. "Oh," I said, half in joke and half in earnest, "adopt the horse-shoe nail mode of levying your penalties: inflict, as you do now, 20*l.* for the first day's delay, but increase it to 40*l.* for the second, 80*l.* for the third, 160*l.* for the fourth, 320*l.* for the fifth, 640*l.* for the sixth, and no pay at all for the conveyance of the mails if the ships are seven days beyond the time stipulated in their contract, and you will be no longer troubled with tenders professing to deliver your letters in less time than the passage, under ordinary circumstances, can be accomplished."

A scheme of penalties, somewhat after this fashion, was immediately afterwards adopted; but I had unwittingly prepared a stick to break my own back. The second contract for the Cape and India mails, to which I have referred in the text, was one of the earliest to which this new principle was applied, and I could not of course object to the stringency of this new fashioned penalty clause, as it was of my own creation. Nor did the Government hesitate to put it in force when my ships were behind time, as also in the case of the unfortunate European and Australian Steam Navigation Company. But though the new principle promptly and effectually put a stop to all tenders of the class of which Mr. Wilson complained, it was much too rigorous to be continued and was abolished.

Australian steam services.

Among the instances where anything like success has attended steam voyages direct to Australia, may be mentioned the services performed by Messrs. Gibbs, Bright, and Company, in their steamship *Great Britain* from Liverpool, and in the steamers belonging to Messrs. Money Wigram and Sons, of London, which now trade to these colonies. Occasionally other steamers are despatched to Australia and also to New Zealand, and recently a company was formed—the Australian Direct Steam Navigation Company—with the intention of maintaining a regular monthly line from London to Melbourne, calling at Falmouth, the projectors anticipating the performances of the passage in "under forty-five days." But though this undertaking failed at the outset, and experience can alone test the realization of the sanguine expectations of its promoters, it may be said in favour of their views, that the difficulties previous pioneers of steam-vessels on long oversea voyages have had to encounter are being rapidly surmounted by the new compound engines, where the consumption of coals required to attain a given speed is not one-half of what it was twenty years ago.

Mr. Alfred Holt's line of steamers to China.

So far as regards the trade with India and China by way of the Cape of Good Hope, the steam-line started by Mr. Alfred Holt of Liverpool in 1865 is the only one within my recollection, which has hitherto proved successful. Though the steamers of this line now proceed to China by the Suez Canal, their performances were remarkable when engaged in the former route. Starting from Liverpool they *never stopped till they reached Mauritius, a distance of* 8500

miles, being under steam the whole way, a feat hitherto considered impossible; thence they proceeded to Penang, Singapore, Hong Kong, and Shanghai, and, though unaided by any government grants, performed these distant voyages with extraordinary regularity.

In forwarding the particulars of his first three vessels, Mr. Holt[1] remarks: "Since the Suez Canal was opened I have found that the square sails of the *Agamemnon*, *Ajax*, and *Achilles*[2] were of little use, and, therefore, I have converted these three ships into what the Americans call 'barquentine rig' (i.e. no square yards on mainmast), and have constructed all my new ships with pole-masts only."

[1] Mr. Alfred Holt is the third son of my old friend, the late Mr. George Holt of Liverpool. He is an engineer by profession, having served his apprenticeship to Mr. Edward Woods, the engineer of the Liverpool and Manchester Railway. Afterwards, he became the inspecting engineer of my steamers and of those of others; and when he himself, in time, became the owner of steam-ships, in partnership with his brother, Mr. Philip H. Holt, he showed what knowledge, practically gained, could achieve, and, thoroughly beating his old employers by the production of the vessels to which I refer, he now ranks high, and deservedly high, among the great shipowners of his native town. Though he has no claim to be considered the inventor of the compound engine, for that is almost as old, in one form or another, as the present century; he was the first to apply the principle on *long oversea voyages*. The ships of the Pacific Company had, it is true, that description of engine in use before him, but only in those of their ships engaged in the coasting trade of the Pacific. Mr. Holt's steamers were consequently the first to show the advantages to be derived from the compound principle on such voyages as those from England to Mauritius, a distance of 8500 miles without stopping, then a marvellous performance; and it was, only, from the time he thus *practically* demonstrated the great value of such engines, that they have been generally adopted.

[2] The *Achilles* left Foochow, July 16th, 1869, and arrived at London round the Cape of Good Hope, September 16th, having been fifty-eight days nine hours under steam—13,552 miles.

Its success.

These three vessels are each 2270 tons gross or 1550 net register, with engines of 300 nominal horse-power.[1] Messrs. Holt have also eleven other steamers, similar in size and power, at present engaged in trade with the East, and three more in course of construction, besides a tug-steamer of 350 tons to attend on them in their passage through the Suez Canal. They carry goods right through to Penang, Singapore, Hong Kong, and Shanghai, calling at Galle and Amoy, or other ports in the Eastern seas when required; and one is struck with the low rates at which goods are now conveyed[2] to India and China compared with the freights charged by the sailing-vessels of the old East India Company, together with the wonderful regularity and expedition[3] with which they are delivered.

Although the fleet of this spirited undertaking is known as the Ocean Steam-ship Company, it is neither a public nor a limited company, the vessels

[1] Their dimensions are as follows: 309 feet in length, 38½ feet beam, and 28½ depth of hold to upper or spar deck.

[2] Freight for ordinary packages of measurement goods:

To Suez, Penang, and Singapore, 50*s*. per ton, with 5 per cent. primage.

To Hong Kong and Shanghai, 50*s*. per ton, with 5 per cent. primage.

Through bills of lading are signed for—

Yokohama, Foo-choo-Foo, and Amoy, @ 90*s*.

Manilla, 90*s*., Batavia, 80*s*., Samarang, 84*s*., Sourabaya, 85*s*., Padang and Macassar, 92*s*., Chiukiang, 77*s*. 6*d*., Kiukiang, 80*s*., Hankow, 85*s*., Nagasaki, 75*s*., and Hiogo, 80*s*. per ton.

All without primage. No bill of lading signed for less than 2*l*. 2*s*.

Freight payable on delivery of bills of lading.

[3] The *Agamemnon* left Hankow, 604 miles above Shanghai, on May 25th, 1873, and arrived (by way of the Suez Canal and Gibraltar) at London, July 12th. The mails, which left Shanghai June 1st, arrived in London *viâ* Brindisi, July 21st, and the passage of the *Agamemnon* is not an exceptional one.

being owned in shares under the old law by a few individuals (like many others of a similar description in this country), but chiefly by the managing owners, Mr. Alfred and his brother Mr. Philip H. Holt, whose thorough business habits have materially promoted the success of the company.

It would be impossible to notice within the limits of this work the different lines of steam-ships now trading to the East by way of the Suez Canal. Among the most conspicuous, however, may be mentioned those of Messrs. Gellatly, Hankey, Sewell, and Company, London, which, from the order and regularity of their despatch, bid fair to rival the subsidized companies. Many of the vessels under their agency belong to Messrs. Thomas Wilson, Sons, and Company, of Hull, long known as large owners of vessels trading from that place to various ports in the Baltic, but who, since the opening of the Suez Canal, have established a line of very fine steam-ships from London to India.

Messrs. Gellatly, Hankey, and Company.

Their *Hindoo* for instance, of 3257 tons gross register, has capacity for about 3500 tons weight, "including coals in bunkers, and from 80 to 120 passengers," for whom accommodation is provided "amidships, a method which has apparently given great satisfaction to those who have been travellers by them."

Another line of steamers under the management of the same firm run in connection with the British India Steam Navigation Company, taking passengers and mails to Columbia, Madras, and Calcutta, with branch steamers from Aden to Zanzibar on the one hand, and to Karáchí and the Persian Gulf on the other.

Foreign nations have likewise taken advantage of the opening of the Suez Canal to run lines of steam-ships to the East; and, besides the French Messageries Maritimes, there are the Austrian Lloyd's Company of Trieste, and the Rubbotino Company of Genoa, respectively supported by the Austrian and Italian Governments, each running a fortnightly line to Bombay during the four best passenger months of the year, namely, from January to April, and despatching their ships every month during the remaining portion of the year.

Messrs. Green and Company.

There is also the "Ducal" line from London, running in connection with the old and celebrated sailing-vessels belonging to Messrs. Green, of Blackwall, which is still maintained; and the "Queen" and "City" lines of steamers direct to Calcutta,[1] as well as various other similar private undertakings. Nor is Liverpool behind the capital in its race by way of the Suez Canal, for that far-famed trade which the Phœnicians, Romans, Venetians, Portuguese, Dutch, and English alike, in turn, have envied and expended untold millions to maintain.

Messrs. Rathbone Brothers.

As a specimen of the ordinary first-class merchant steamers now trading between Liverpool and Calcutta, I may instance one of the vessels belonging to Messrs. Rathbone Brothers, of that place. She is of 2610 tons gross and 1682 tons net register, and has capacity for 2200 tons of cargo, besides

[1] The *Queen Margaret*, 3138 tons register, belonging to the Queen Steam Shipping Company (Limited), has just (Sept. 1875) made the passage from London to Calcutta under 30 days, including 40 hours' detention in the Suez Canal (or, 28 days and 8 hours), which, as yet, is, I believe, the fastest passage on record.

450 tons of coal.[1] She is rigged merely with poles (a mode of rig now becoming very general in all steam-vessels), on which, with the exception of one fore-square sail, a few fore and aft sails alone can be set. The owners remark the "best passages of our ships as yet are as follows:—Liverpool to Calcutta (viâ Gibraltar) to Saugar (near Calcutta), thirty-one days, including all stoppages; Calcutta to London (viâ Galle and of course Suez Canal) to *Nore* light-ship, thirty-four days thirteen hours, steaming time on the whole voyage (exclusive of Suez Canal and stoppages) sixty-one days twelve hours. The best homeward passage hitherto made by any of our ships, landing cargo at Colombo and Port Said, occupied thirty-three days seventeen hours, inclusive of all stoppages."

From these and previous figures, my readers will more fully understand the progress that has been made in our ordinary trading communications with India and China, since the days of the East India Company, and ascertain what has been gained, since then in the speed, capacity, and current expenses of our merchant-ships.

Messrs. George Smith and Sons.

In further illustration of the progress made in our own time I cannot do better than furnish my readers with a letter I received (January 1875) from Mr. George Smith, of Glasgow.

Indeed, this letter contains in itself a history of the rise of the merchant-vessels of Great Britain during the period to which Mr. Smith refers, and marks the different stages of progress and the

[1] The dimensions of this vessel are 350 feet in length, 37 feet in breadth, and 27 feet 5 inches extreme depth of hold. She has three decks, her engines are 300 nominal horse-power, and her crew consists of fifty persons all told.

means whereby we have been enabled not merely to maintain, but to surpass, in maritime supremacy, all nations. It, likewise, illustrates how individuals (for the case of Messrs. George Smith and Sons is no exception to the general rule, though their operations may be on a more extensive scale than those of most other shipowners) have, since they have been relieved from the trammels of protection and been left to exercise as they deem best their own genius and industry, more than kept pace with other branches of commerce by the improvement and increase of their ships.

"Our first purchase," Mr. Smith states in his letter, "was a small colonial barque in 1840, which was followed shortly thereafter by the purchase of a barque of 346 tons, in course of construction, and a ship of 500 tons then nearly in frame, both being of the ten years class.

"The first ship which we contracted for and had built to our own specification was the *Majestic*, launched in 1846. Our second, the *City of Glasgow*, was built at Kelvinhaugh, and launched in 1848. While she was on the stocks, the bounds of the municipality of Glasgow as a city had been extended to the junction of the Kelvin and Clyde westwards, and thus embraced the shipyard in which she was built. Our late Mr. R. Smith was then a magistrate of the city of Glasgow, and this being the first ship built in the extended royalty, we reckoned no name could be more appropriate, and, as other ships came into existence, we still kept the *City*,[1] and merely added a name in future designations.

[1] All the ships of Messrs. George Smith and Sons are named after different cities.

"When we commenced the trade, we employed the regular brokers for loading outwards, and had every reason to be satisfied with the attention paid to our interests by the gentleman who did our business, but the practice, which then obtained here, of laying a ship on the berth and allowing her to lie till nearly loaded before naming the sailing date, and that date, when named, frequently not adhered to, we felt very annoying, not only as keeping back shipments but as sending goods to Liverpool which should have gone from this direct. Our rule was to have our dates of sailing definitely fixed. Only one firm, however, in the trade held the same view with ourselves, and feeling the annoyance, they and we resolved on starting a monthly line to Calcutta. Together we had not so many vessels as were required to keep up the monthly conveyance, but we resolved to add to our tonnage and make up for the then deficiency by chartering so far as necessary. We had made a special stipulation that *our* broker should still act for *our* ships, and also for those that it might fall to our lot to charter. When this proposal was submitted to him we were surprised to find that he declined very decidedly to have anything to do with the arrangement—that his lengthened experience in the trade satisfied him that it would prove a failure—and he was therefore not prepared to allow his name to be associated with it; but he lived long enough to find he had been mistaken.

"Having experienced the difficulty arising from brokers acting to-day for a party who adhered to their date, and to-morrow for another who would not let their vessels go until filled, we at once

Messrs. Smiths' ships, and their voyages to and from India.

decided on taking charge of the loading ourselves, which we still continue. After this we went on steadily increasing our fleet of sailing-ships until those afloat numbered thirty-five. Our last contract for a sailing-vessel was in September 1868.

"For several years, our operations were confined to Calcutta, but, in 1863, at the solicitation of several friends, we started a monthly line to Bombay, having in the meantime increased our sailings very materially to Calcutta as well. The following statement shows the number of voyages completed to each port in 1871, and is a fair estimate of the work of the previous eight years. We had, in fact, a virtual monopoly of the trade, gained by strict punctuality—a high class of ships and moderate charges, ever studying to arrange rates that our friends could not go past us to do better.[1]

"Our first *iron* ship was launched in 1856; our wooden ones were disposed of as opportunity offered,

[1] CALCUTTA.

We despatched to Calcutta vià the Cape of Good Hope, in 1871, twenty-four sailing ships:

Shortest passage out	79 days.
Ditto ditto home	93 days.
Shortest round voyage, Pilot to Pilot	6 months and 9 days.
Average passage out	95 days.
Ditto ditto home	108 days.

Five of the voyages were completed under seven months. A few of these vessels loaded out from London. The others were all from the Clyde.

BOMBAY.

We despatched to Bombay, in 1871, sixteen sailing-ships completing the same number of voyages:

Shortest passage out	83 days.
Ditto ditto home	95 days.
Average ditto out	106 days.
Ditto ditto home	117 days.
Shortest voyage	7 months and 18 days.

and, in 1868, only one of these remained, which we have since sold.

"We commenced steam in 1871, by contracting for four boats of 2250 tons gross, and about 1700 tons register, having compound engines of 200 horse-power, working up to 1000. The boilers have been a serious source of annoyance to us from the first. When all goes right, we get 9 to 9½ knots out of them, and make the passage (viâ Suez Canal) in thirty-nine days including stoppages; but the irregularity attending their working prevents us from giving you a list of their passages as desired; latterly, we have added two of a larger class and more power. These have been making the passages regularly in thirty-one to thirty-three days, and we anticipate equal results from other four now in course of construction."

Changes in the mode of conducting commerce with India and China.

In the brief account thus given we have a condensed history of the changes and progress of the merchant ships of Great Britain during the last thirty-five years, so far as regards our trade with India. Step by step, they rise from wood to iron and increase in size from 350 to 1500 tons as sailing-ships, while these in turn are now being to a large extent supplanted by iron screw-steamers of from 2000 to 3000 tons and upwards. In most respects, the sailing-ships of Messrs. Smith and Son very much resemble the finest of the modern free-trade Indiamen, whereof a drawing has been furnished;[1] and their steam-ships are not unlike the more recent vessels of which various illustrations are given in these pages; their *City of Oxford*, for instance, of 2220 tons gross, carries 2500 tons of Calcutta cargo,

[1] See vol. ii. p. 493.

besides 750 tons of coals in her bunkers; and she is navigated by forty-nine persons, comprising commander, surgeon, two officers, twenty seamen, seventeen men in the engineer's department, and eight persons otherwise employed.[1]

Such are the vessels now carrying on the more valuable portion of our trade with India, through that great maritime highway, which the genius and industry of De Lesseps has so recently opened to our vast commerce with the far East, three-fourths of which, however, is still conducted by the way of the Cape of Good Hope.[2]

Number of vessels through Suez Canal since its opening, and their nationality

In the Appendix to this volume[3] will be found an account of the vessels which have annually passed through the Suez Canal since that great undertaking was opened, specifying the different nations to which they belong. Some interesting

[1] The dimensions of this ship are 325 feet in length, 37 feet beam, and 27½ feet extreme depth. The cylinders of her engines (compound) are 39 and 68 inches respectively in diameter and the length of stroke 42 inches.

[2] I may here state that the bulkiest articles of Indian produce, consisting as they do of cotton, jute, rice, sugar, saltpetre, cutch, and such like, as also woods of various kinds, cannot, as a rule, afford to pay the rates necessary to remunerate a steam-ship for their conveyance; hence, such articles will most likely continue to be sent to Europe by the Cape route, except when in special demand. That such will most probably continue to be the case is apparent from the fact that, though, during the last two years, the competition between the steamers passing through the Suez Canal has been so great as to reduce their rates of freight almost to a level with those paid to sailing-vessels, the latter still continue to secure full cargoes. This may, in some measure, be accounted for by many, indeed, the bulk of those cargoes being sold "to arrive:" hence, merchants frequently prefer sailing-vessels, especially for the shipment of jute, rice, and other articles of comparatively low value, as thus they have a longer time at their disposal, and thus frequently avoid the expense of warehousing, to which, in the case of goods by steamers, they are often obliged to resort, from the short time allowed in all contracts, for the discharge of such vessels.

[3] Appendix No. 25, p. 643.

and instructive facts may be gathered from these returns, especially with regard to the remarkably rapid growth of the traffic, increasing as this has done from 486 ships of 435,908 tons in 1870, to 1264 ships of 2,423,672 tons in 1874. Nor is it less worthy of notice that more than three-fourths of the whole of this tonnage belongs to Great Britain.[1]

[1] In calling attention to the results of the construction of the Suez Canal, the *Friend of India* says:—"No more striking illustration could be adduced of the revolution effected by the Suez Canal than that suggested by a comparison of the shipping advertisements of to-day with those of twenty years ago. Then we hardly ever heard of steamers in these regions, except in connection with the stately proceedings and crushing fares of the Peninsular and Oriental Company. Then, it was a splendid run to get home in one of Green or Smith's clippers in ninety days. Now, an ordinary cargo steamer, carrying a few passengers, lands us comfortably at Liverpool on the thirtieth day. First we have the time-honoured Peninsular and Oriental Company, next the Messageries Maritimes de France, then the Italian Steam Navigation Company. Not inferior to the last-mentioned is the Austro-Hungarian Lloyd's Steam Navigation Company, then comes the Anchor line, followed by the Wilson line, the Star line, &c. Besides the regular steamers of these and similar 'lines,' we have our choice of a large and constantly increasing number of private vessels—less regular, perhaps, in their departures and arrivals, but many of them not a whit inferior in size, accommodation, speed, and careful management. Another note-worthy feature in these noble steam fleets is the nature of the vessels generally composing them. It will be found that nearly the whole of the steamers are new, many of them having been built expressly for the Indian passenger trade; and all are superbly fitted out with every convenience and luxury. Twenty years ago, a vessel of 1500 tons ranked as the largest of our Indian sailing-vessels. Now, 3000 tons is a very common figure to see appended to the name of a passenger steamer, and 4000 tons not uncommon, while some are considerably above that tonnage. In point of speed, several steam vessels owned by new companies are equal, if not superior, to the Peninsular and Oriental. Recently we read of a steamer leaving Suez two days after the Peninsular and Oriental, and arriving at Bombay one day earlier. The lowering of fares is another item worthy of consideration. A first-class passage can now be obtained, exclusive of beer and wine, for 450 rupees. The result of all this is a greatly increased and rapidly increasing flight to England from India; and an annual accession of visitors and tourists from England, the Continent, and America, to India. Even our hill stations are losing their summer

Figures such as these may in some measure set at rest the fear long entertained that the opening of this canal would be prejudicial, in any material extent, to the interests of England, by diverting the course of commerce with India to its former European centres, and restoring the commercial greatness of Constantinople, Venice, Leghorn, Marseilles, Cadiz, and Lisbon. For, though these places cannot fail to be benefited to a greater or less extent, and they have already been so, by the re-opening of the ancient route, their superior position to that of the ports of Great Britain will be of little avail, till they adopt the policy pursued with so much success by this country. If they desire to secure that share of the commerce of India, to which from their natural position they may fairly consider themselves entitled, they must open their ports to the ships of all nations, sweep away their differential and protective duties, establish docks and bonding warehouses, and offer to the traders of the world equal facilities for obtaining whatever description of its assorted produce they may require for their varied wants. The mere fact of being a few days nearer Calcutta or Bombay will otherwise avail them little, distance in itself being now of comparatively small importance to what it was before steam-ships traversed the ocean.

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visitors—drained off by the absorbing Suez Canal. And many parents, who formerly sent their children to hill schools, are now taking advantage of cheap passages to give them the benefit of home education. As fares are reduced still more this homeward tendency will further increase. Why should not 30*l.* pay as well for thirty days without beer and wines as 60*l.* used to pay for ninety days with beer and wines? We believe that first-class passages will eventually be procurable for 30*l.*, and that now is the time for shipping companies to look the future in the face."

CHAPTER XII.

First application of steam-vessels on the rivers and coasts of India, 1825—S.S. *Diana*—S.S. *Burhampooter* and *Hooghly*, 1828—Arrival in India of Lord William Bentinck as Governor-General—His efforts to promote Steam Navigation — Voyages of the S.S. *Hooghly* up the Ganges 1828, 1829, and 1830—Other vessels recommended to be built—Two of them of Iron—Steam Companies formed, 1845—Steam Committee, 1857, and rapid progress of steam-vessels from this date—Improved troop steamer for the Lower Indus—Sea-going steamers of India—S.S. *John Bright*—British India Steam Navigation Company established, 1857—Its fleet, and extent of its operations—Origin of this company—Its early difficulties, and rapid extension—Number of ships lost—Effect of the opening of the Suez Canal on the trade of this Company—The *Holy Ship*, *note*—Netherlands Steam Navigation Company, 1866—Its fleet, and how employed—Irrawaddy Flotilla and Burmese Steam Navigation Company, 1865—Services of this Company—Extent of inland trade—Fleet of the Company—Interior trade of China—The Yang-tse-Kiang—Its source and extent—Opened to trade, 1860—First steam-ship direct from Hankow to England, 1863—Passage of the *Robert Lowe* and her cargo—Number of steamers employed on the Yang-tse 1864 and in 1875—S.S. *Hankow*—Her power and capacity, *note*—Chinese Steam Navigation Company—Proposed Imperial fleet of steamers—Increase of trade with China—The resources of the interior—Mode of conducting business—"Hongs" or Guilds—Chinese Bankers—River and coasting trade of China—Japanese line of steamers—How employed.

First application of steam-vessels on the rivers and coasts of India, 1825.

ENCOURAGED by the success of the *Enterprize*, the Bengal Government soon afterwards purchased another steamer, the *Diana*,[1] which had been originally

[1] The *Diana* was sent out first in 1821 for Mr. Robarts, with the view to employment in the Canton river. She had a pair of 16 horse-

sent from England to China on speculation, and despatched her to Amarapura, 500 miles up the River Irrawaddy, with their then Resident in Burmah, Mr. Crawfurd, and his suite. As, however, she sailed on her voyage in the month of September, when that river is at its fullest, her progress not exceeding 30 miles each day, caused considerable disappointment to the Indian Government. On her return in the following month of December, she was again equally unfortunate, for, by that time, the river had fallen so low, that, partly owing to her draught of water, which was seldom less than 6 feet, and, partly, to the intricacy of a navigation, then imperfectly known, her passage down the Irrawaddy was nearly as tedious.

S.S. *Diana.*

As, however, this voyage was accomplished without accident, the value of steamers for inland navigation was sufficiently shown to induce the Indian Government to consider the desirability of constructing such vessels for this special service; hence, an urgent application was soon afterwards

power engines by Maudslay. At Calcutta she was nearly reconstructed by Messrs. Kyd and Co., and launched again on July 12, 1823.

The first actual steam-boat of which we have any record, in connection with India, was built at Batavia, shortly after the conclusion of the Java war in 1810–11. She was called the *Van der Capellen*, and was built at the expense of English merchants. She was engaged by Government for two years at the cost of 10,000 dollars a month, which well repaid the original outlay on her. She proved very effective for the transport of troops, &c. After some years she came into the hands of Major Schalch and was used by him, under the name of the *Pluto*, as a dredging-boat in 1822. Thence she went to Arrakan as a floating battery. She was afterwards lost in a gale in 1830.

In 1819, Mr. W. Trickett built a small steam-boat of 8 horse-power at the Butterley Works, for the Nawâb of Oude, to ply on the Jumna. ("Early Steam Navigation to India," by G. A. Prinsep, Calcutta, 4to, 1830.)

made to the Court of Directors for permission to build two vessels, one for general service, and the other for the navigation of the Burhampooter, on which, from the strength of the stream and the prevalence of easterly winds, it was found that sailing-vessels could not be depended on, for the supply of the large number of troops it was necessary to maintain in the valley of Assam for some years after the conquest of that country. So much delay, however, occurred before the Court gave its consent, that these vessels were not ready for actual service till the spring of 1828.[1]

The S.S. *Burhampooter* and *Hooghly*, 1828.

Lord William Bentinck, who arrived on July 3rd of that year at Calcutta, as Governor-General of India, at once saw the immense advantage to be derived from the employment of steam-vessels, and their great value and economy in the rapid transport of troops and treasure, as well into the interior as along the coasts of India.[2]

Arrival in India of Lord William Bentinck as Governor-General;

No arguments were required to convince him that the new steamer despatched for service on the Burhampooter river, whence she had been named, was

[1] These vessels were named the *Burhampooter* and *Hooghly*; they were each 105 feet in length and 18 feet in breadth. Each had two engines, which were sent from England, of the combined nominal power of 50 horses, but working up to 80 horse-power on a consumption of 709 pounds of coal per hour.

[2] Previous to 1828, owing to the bad state of the Ganges, arising from the sand-banks and heavy floods, against which native genius and native boats were unable successfully to contend, communication with the interior was alike slow and expensive. Thus, it took two and a-half months to go from Calcutta to Benares; three and a-half to Caunpore; six to Agra; and seven and a-half to Delhi. The premium of insurance on a voyage from Calcutta to Caunpore was 3½ per cent. —as much as to England. Treasure, too, and other valuable property was constantly lost by the upsetting of the boats.

of almost incalculable value, the troops in Assam being not merely supplied more rapidly with the necessary stores, but their number materially reduced, the use of steamers enabling the different armies of India to be practically interchangeable with almost every portion of the East. Consequently, Lord William Bentinck appointed a committee to inquire into the description of steamers best suited for the navigation of the rivers of India, and ordered the *Hooghly*, the second vessel built, to explore the River Ganges as far as Allahabad, a distance of 798 miles above Calcutta.

His efforts to promote Steam Navigation;

The voyages of this vessel, under the command of Captain Johnston, previously of the *Enterprize*, were perfectly successful, and clearly showed that the Ganges could, for the whole of this distance, be advantageously navigated by steamers. Although the *Hooghly*, from not having the indispensable qualities of lightness of draught, capacity, and speed, was not well adapted for so long and intricate a river voyage, she made the passage to Allahabad at the average speed of 3½ miles an hour, against a current of from 3 to 4 miles, returning thence at the rate of from 7 to even 12 miles an hour according to the strength of the stream. Further experimental trips in the spring of 1829, and in January 1830, were equally successful.

Voyages of the S.S. *Hooghly* up the Ganges, 1828, 1829, and 1830.

In accordance with the recommendations of the Committee, two steamers of about 270 tons burden, with engines of 70 to 80 horse-power, were constructed as tug-boats for use on the river *Hooghly*; and orders were sent to England for two others, better fitted than the *Burhampooter* and *Hooghly*, for the

Other vessels recommended to be built;

navigation of the Ganges or other rivers. These vessels had, indeed, but partially met the wants of the service, and, as it had been now discovered that vessels of less draught could be made of iron, the Court of Directors were recommended to order their construction of that material. They were to draw not more than 2 feet of water; one to be a steam-tug, the other an accommodation boat. Both were to be of the same dimensions, 120 feet long, by 22 feet in width, and very flat-bottomed, which, indeed, was absolutely necessary to secure the stipulated lightness of draught. They were to have two engines of 30 horse-power each, with vibrating cylinders, on account of their greater lightness. However, till the result of the experiment made with these boats was known, the Directors suspended their decision as to the building of more steam-vessels for the navigation of the Upper Ganges and Burhampooter, as also for that of the Indus and other rivers of the Punjâb.

Two of them of iron.

In these early efforts, we have an approximation to what has since been achieved on the rivers of India, presenting, as they did, a field for inland navigation, realizable by steam-vessels with far more advantageous results than could be obtained by the ordinary craft of the country. The success of the first effort, in securing a high power of engines as compared with the draught of water, led to the construction, for similar purposes, of various other iron boats by Mr. Laird, Messrs. Miller and Ravenshill, and Messrs. Forrester.

Private enterprise, however, in this instance lagged

Steam companies formed, 1845.

behind Government, as it was not till 1845 that any companies were formed to conduct the trade of that country by means of steam-vessels. The Tug Company of the Hooghly was among the first of these commercial undertakings. The Bombay Steam Navigation Company followed, with four paddle-wheel steamers, three of wood and one of iron, to trade beween Bombay and Ceylon on the one hand, and Karáchi on the other. But, however great the advantages derivable from the use of steamers on the rivers and coasts of India, their development, even then, was slow compared with that of Great Britain or the United States. Although starting early, and with energy, in the use of this new power, the people and Government alike seem to have slumbered for nearly thirty years, and to have been dreaming over its advantages: indeed, it was not till 1857, when another committee had been appointed, and strongly recommended the more extended use of steamers, that any very marked progress was made. From that period, however, it has been very great, I may say remarkable, more especially since the opening of the Suez Canal. Since then, those ancient routes of maritime commerce which, in the dawn of history, were first tracked by the Chaldeans and Phœnicians, and, afterwards brought into a system by the greatest and wisest of monarchs, have been, after the lapse of more than two thousand years, re-opened by steamships, and this, too, almost along the same course, which Solomon, in connection with Hiram, King of Tyre, first established.

Steam committee of 1857,

and rapid progress of steam vessels from this date.

Among the finest vessels ordered by the Government of India after the report of the committee had been considered, may be mentioned one designed by Mr. T. B. Winter, C.E., for the navigation of the Lower Indus. As she is very much the type of all the steamers now employed for the conveyance of troops and passengers on the rivers of the East, I may state that her design somewhat resembles (though with special fittings adapted for the climate of India) the steamer, now employed on the River Hudson, already described,[1] having accommodation for 800 soldiers and their officers in two tiers of cabins, one above the other, built on the main-deck, and surrounded by verandahs and covered with awnings as a protection from the scorching rays of the sun. The sides of these deck-houses, consist almost entirely of Venetian blinds; their frames and those of the berths being made of galvanized iron, having between the frames sheets of perforated zinc so as to admit a free circulation of air, while the whole range of these houses is divided into five separate compartments so as to permit the separation of the troops in case of sickness. By an ingenious contrivance an abundant supply of fresh air is drawn from the paddle-boxes in order that it may contain moisture, and is supplied to all the cabins by means of fans, worked by the steam-engines of the ship in such a manner that a sufficient quantity is provided to completely change, every half-hour, the air in each troop-room. The draught of water of this commodious and beautifully arranged vessel, aided by another ingenious contrivance in connection with

Improved troop steamer for the Lower Indus.

[1] See ante, vol. iv. p. 145.

her rudder, does not exceed, when laden, 2 feet, while her speed on her trial trip averaged close upon 12 statute miles the hour.[1]

Sea-going steamers of India.

Among the earliest commercial Ocean Steamers employed on the Eastern seas, were, as noticed previously, those of the Peninsular and Oriental Steam Navigation Company. For some years, at first, these vessels held almost a monopoly of the passenger and of the most valuable portion of the goods traffic. Competitors, however, soon arose, especially in the opium trade, which had, hitherto, been conducted by sailing clippers celebrated for their speed, many of which vessels, owned by English merchants resident in Hong Kong, had proved a large source of profit to their too enterprising owners. But, now, the whole of this trade, as well as a considerable portion of the traffic between Calcutta, Bombay and the Chinese ports, is carried on by very fast steamers, owned partly by English and partly by native merchants. A few years ago, one of the finest of these vessels

[1] This vessel was built by Messrs. M. Pearce and Company, of Stockton-on-Tees, and her principal dimensions are as follows: length over all, 377 feet; beam, 46; breadth over paddle-boxes, 74; depth of hold, 5 feet; working draught of water, 2 feet; displacement at 2-feet draught, 739 tons. The engines (built by Messrs. James Watt and Co., of London and Birmingham) are 220 nominal horse-power, having horizontal cylinders of 55 inches diameter, and 6-feet stroke, and the diameter of the paddle-wheels is 26 feet. The hull of the vessel is constructed of puddled steel, and is strengthened longitudinally by four arched girders, two of which carry the paddle-wheels, while the other two run fore and aft, extending nearly the whole length of the ship. Similar means are employed for strengthening the vessel athwartships. She is steered at each end by means of "blades," which, instead of being worked from side to side in the ordinary manner of rudders, are made to rise out of, or lower into, the water at the proper angle. Both sets of these "steering-blades" are worked simultaneously, but provision is made to work one set only, should an accident occur to the other.

was the property, entirely, of Parsees resident at Bombay, and, as she bore the honoured name of the *John Bright*,[1] it is to be hoped that opium constituted but a small portion of her cargo. I mention her, however, as a fair specimen of the steamers thus employed, both as regards speed and dimensions, and, for the information of my readers, I may state that she was built of iron by Messrs. C. J. Mare and Co., of Millwall, in 1862, and that she made the voyage from Gravesend (calling at the Cape of Good Hope) to Bombay in fifty-eight days, and thence to Hong Kong, with a full cargo, and against the monsoons, in twenty-two days.[2] S.S. *John Bright.*

Much the most important commercial maritime company, however, now engaged in the coasting trade of the East, is the British India Steam Navigation Company (Limited), which commenced business in 1857 under the title of the Calcutta and Burmah Steam Navigation Company, with a line of steamers between Calcutta, Akyab, Rangoon, and Moulmein. In 1862, the name of the company was changed to its present designation, its operations having been extended along British India Steam Navigation Company established, 1857.

[1] The *John Bright* is clipper form, barque rig, and fitted with the screw. Her dimensions are 250 feet in length between the perpendiculars: breadth 31 feet, and depth 22 feet 6 inches. She is propelled by engines of 250 horse-power nominal; and is 1192 tons builders' measurement.

[2] The earliest, as well as at that time, the fastest steamers employed in the opium trade between Calcutta and China were the *Fiery Cross*, and the *Lancefield*, built on the Clyde, and owned by Messrs. Jardine, Matheson, and Company. These vessels invariably called at Singapore on their way to Hong Kong, where they waited for despatches from England by the steamers of the Peninsular and Oriental Steam Navigation Company. Thus the owners of these vessels, which were much faster than the Mail boats, not merely realized large profits in their regular trade, but, with earlier information from home, than their competitors, had a great advantage in all other branches of commerce, as well as in that of opium.

the coasts of India and Persia, so as to embrace, at the present time, a continuous coasting service between Singapore on the one hand, and the island of Zanzibar on the other, with an extension from the latter port to the French settlements of Mayotte, Nossi Bé, and Majunga. The fleet of this company now consists of forty-two iron screw-steamers, varying in size from 350 to 2600 tons gross register, their aggregate gross tonnage being about 57,000, employed on thirteen different lines,[1] showing the vast extent of commercial intercourse now maintained by the vessels of this one undertaking alone.

Its fleet and extent of its operations.

One is amazed at the rapidity of the growth of steam-ship companies throughout the world, within the last quarter of this century. It seems only the other day when Mr. Mackinnon of Glasgow, a merchant engaged in the trade with India and the founder and managing director, as well as one of the chief owners of this large fleet of steamers, mentioned to the author his intention of running a couple of small steam-vessels between Calcutta and Burmah.

[1] Lines of communication maintained by the steamers of the British India Steam Navigation Company (Limited): Line 1. Between Calcutta, Chittagong, Akyab, and Kyouk Phyoo, fortnightly. 2. Between Calcutta, Akyab, and Rangoon, fortnightly. 3. Between Calcutta, Rangoon, and Moulmein, weekly. 4. Between Calcutta, Chittagong, Akyab, Kyouk Phyoo, Sandoway, Bassein, Rangoon, Moulmein, Tavoy, Mergui Pakchan, Kopah, Junkseylon, Penang, Malacca, and Singapore, every four weeks. 5. Between Moulmein, Penang, Malacca, and Singapore, fortnightly. 6. Between Calcutta, Port Blair, Camorta, and Rangoon, fourweekly. 7. Between Madras and northern ports to Rangoon, fortnightly. 8. Between Calcutta and Bombay, calling at ports in the Coromandel and Malabar coast ports, weekly. 9. Between Bombay and Karáchí, twice a week. 10. Between Bombay, Karáchí, Muskat, Bunder Abbas, Linga, Bushire, and Bussorah, weekly. 11. Between London, Lisbon, Algiers, Red Sea ports, Karáchí, and Persian Gulf, every four weeks. 12. Between Aden and Zanzibar every four weeks. 13. Between Zanzibar, Mayotte, Nossi Bé, Majunga, Mozambique, and other East African ports, every four weeks.

Nor was he then very sanguine of success. With the shrewdness, however, characteristic of his countrymen, he saw, beyond the difficulties he would have to encounter (which men of his determination and perseverance alone know how to overcome), an important and valuable opening for the employment of steamers, and having overcome every obstacle, his hopes have been more than realized; indeed, much sooner and to a far larger extent, than he or any one else could at the first have anticipated.

Origin of this company. This now important undertaking had its origin in an advertisement by the East India Company in 1855, for steam-vessels to convey the mails between Calcutta and Burmah, a service hitherto conducted by their own vessels, the *Enterprize* being the first to do so. Mr. Mackinnon and his partners, having agreed to accept the contract, despatched for its fulfilment the *Baltic* and *Cape of Good Hope*, but these vessels, being unsuitable for the purpose, and having made long and expensive passages to India, their enterprising owners would have suffered a heavy loss by them, had they not, soon after their arrival, been engaged for the transport of troops at the outbreak of the mutiny.

Its early difficulties, Nor was the new company more fortunate with the first vessels they built on the Clyde for this trade. One of these, the *Calcutta*, of 900 tons, was totally wrecked off the coast of Wicklow soon after she left Greenock, while another, the *Cape of Good Hope*, was sunk in the Hooghly, having come into collision with one of the steamers of the Peninsular and Oriental Company. The losses thus

and rapid extension.

sustained were, however, vigorously overcome; other new vessels were supplied and, in 1862, a fresh contract was entered into with the Government of India, including conditions for the transport of troops and stores at a mileage rate, and for the conveyance of the mails, not merely every fortnight, between Calcutta, Akyab, Rangoon, and Moulmein, but also once a month, *viâ* the two latter ports, to Singapore; a similar service to Chittagong and Akyab; another to the Andaman Islands in the Bay of Bengal; a fortnightly one between Bombay and Karáchí; another, once a month, between Madras and Rangoon; and a further service, every six weeks, to various ports in the Persian Gulf, along nearly the same route Nearchus had followed three centuries before the Christian era.

Improving prospects now accompanied this spirited undertaking at every stage of its rapid progress. Steam here, as it has done everywhere else, opened up fresh branches of commerce, developed others, or gave new life to occupations for ages dormant, conferring, by its civilizing influence, immense benefits on the dense and often poverty-stricken and oppressed inhabitants of lands at once envied and far-famed.

Number of ships lost.

As might have been anticipated, the British India Steam Navigation Company met with various losses, in the development of so extensive a range of services; but, though the wreck of their *Burmah* on the Madras coast, the loss of the *Bussorah* on her voyage to India, the stranding of the *Coringa* in the harbour of Muskát, and the foundering of the *Persia* on her voyage from Rangoon to Calcutta,

during one of these fearful cyclones which, periodically, sweep the Indian Ocean, crippled for a time the resources and retarded the operations of the company, they did not quell the spirit or even damp the energies of Mr. Mackinnon and his co-directors, who thus, at last, achieved that success which industry and perseverance, in the right direction, must ever command.

Effect of the opening of the Suez Canal on the trade of this company.

The opening of the Suez Canal, in 1869, gave renewed vigour to the company. While producing an entire revolution in the shipping trade of India, it afforded facilities for its economical conduct, hitherto unknown. Of these the directors at once took advantage, and their steamer *India*, requiring new boilers, was the first vessel to arrive in London with a cargo of Indian produce, through the new maritime highway, which the genius and energy of Lesseps had constructed across the barren isthmus of the land of the Pharaohs.

In 1873, the company entered into still more extended arrangements with the Government of India, by doubling some of its existing lines, and, in 1872, the directors arranged with the Home Government to organize a mail service every four weeks, between Aden and Zanzibar, on the east coast of Africa, so that the distance annually traversed under its contracts, now exceeds 1,100,000 miles.

In tracing the different lines used by the vessels of this company, it is interesting, as I have just mentioned, to note that their courses, especially those along the Arabian shore of the Red Sea, the eastern coast of Africa, the coasts of Hadramaut and Persia as far as Bussorah, and by way of Beluchistan and

to the confines of China, a route greatly developed of recent years. It was, as I have stated, on this river, that the second steamer, the *Diana*, belonging to the East India Company, made her first voyage, and, from that time until 1865, the Government of India maintained, with more or less regularity, communication by their own steamers between Calcutta, Rangoon, and Upper Burmah, as far as Mandalay, a city said to contain at one time half a million of inhabitants, and situated on the banks of the Irrawaddy, about 500 miles from the sea.

Irrawaddy Flotilla and Burmese Steam Navigation Company, 1865.

Finding, as Governments often do in such undertakings, that the receipts from this line of communication fell very far short of the disbursements, they, in 1865, made a contract with the Irrawaddy Flotilla and Burmese Steam Navigation Company, constituted under the Limited Liability Act "for the conveyance of H.M.'s troops, stores, and mails to the different stations of British Burmah on the River Irrawaddy, and for carrying on general traffic between the towns and villages on that river from Rangoon to Mandalay, the capital of Upper Burmah,"[1] at the same time making over to the company four Government steamers and three flats previously engaged in the river service. But these vessels, having been found altogether unsuited for the successful carrying on of the company's operations, were soon replaced by other and new vessels,

[1] Mr. James Galbraith, the managing director of this company, is in every respect competent to carry out with success this interesting and important undertaking. He is the chief partner of the firm of Messrs. P. Henderson and Co., of Glasgow, and the senior partner of the firm of Messrs. Galbraith, Stringer, Pembroke and Co., of 8 Austin Friars, London—successors to the firm of W. S. Lindsay and Co., which I established, and from which I retired in 1862.

better fitted for the efficient and economical performance of this service.

When the original contract with the Indian Government expired in 1868, the company entered into a fresh agreement, whereby its services were extended from Mandalay to Bhamo, 1000 miles by river from Rangoon, and within 50 miles of the Chinese frontier. Bhamo, for centuries celebrated among the inland commercial cities of the East, was, at one time, the depôt of an enormous import and export trade to and from western China, conveyed by trains of caravans between that city and Yunnan, the south-western province of the Celestial Empire. But, though long-continued rebellions and civil wars have almost extirpated this important traffic, it has of recent years received a fresh impulse by the introduction of improved steam communication on the Irrawaddy, and by the efforts of English merchants, supported by Government, to explore the country and to re-open vast fields of wealth long comparatively unproductive.[1] **Services of this Company.**

Previously to the establishment of steam communication, the trade of the Irrawaddy, studded along its whole length with towns and villages, with a dense, active, and industrious population, was conducted by native craft of various kinds, whose number has been estimated at 25,000. But steam-vessels, **Extent of inland trade.**

[1] It was in these researches that Mr. Margary, of the China consular service, a young gentleman of great enterprise and promise, recently (February 1875) lost his life, and where, also, various employés of the English Mission, which left Calcutta, in December 1874, to explore the country lying between Bhamo and Hankow on the Yang-tse river, were killed by the treachery of the natives, the mission itself having been forced to return before it reached the Chinese frontier.

by their speed, regularity, and safety, are gradually superseding these native craft, which, in time, will become, as they have done everywhere else, simply auxiliaries to that great power which, in so large a measure, now regulates the commerce of the world.

Fleet of the company.

The fleet of the Irrawaddy Company now consists (1st of January, 1875) of fifteen steamers and twenty-five "flats," the whole built expressly for this trade. The steamers, resembling in many respects (though they are inferior in size) those employed on the Ganges and the Indus, are about 250 feet in length, with 32 feet beam, and only 8½ feet depth of hold. They are built of iron, and their draught of water, with 100 tons of fuel on board, is 3 feet 9 inches. They do not take any cargo, but only passengers, having accommodation for thirty first-class, and from 250 to 300 steerage or native passengers; but each steamer tows a couple of flats or barges fastened on either side. The steamers have engines of 250 nominal horse-power, and can attain a speed of fourteen knots an hour, in still water, and without anything in tow. Though their hold is only 8½ feet in depth, the houses and awning-deck rise to about 18 feet above their hull. The largest of the barges is 195 feet in length, with a beam of 25 feet, and can each carry 300 tons measurement of cargo, weighing about 160 tons, with a draught of not more than 3 feet of water.

There is now a weekly steam service between Rangoon and Mandalay, while every month a steamer ascends to Bhamo, which, though now a wretched place of not more than 75,000 inhabitants, may yet be restored by means of steamers to some-

thing approaching its former importance. As the delta of the Irrawaddy embraces an area of 94,000 square miles, with an alluvial and fertile soil throughout, producing in great abundance rice, cotton, cutch, teak, minerals, and mineral oils, and, as not more than 3000 miles of this rich district of country is as yet under cultivation, it presents an enormous field for the development of maritime and other branches of commerce.

Interior trade of China.

But, as we proceed further to the East, we find still larger and richer fields gradually being opened out by means of steamers. In China there are vast regions with teeming millions of industrious people who could never have been reached by the traders of Europe and America without the intervention of steam; countries hitherto unknown, yet exhibiting a high state of civilization. With all the necessaries and many of the luxuries of life, their inhabitants have little or no knowledge of any other country beyond their own: favoured by a superior soil and excellent climate, they have, however, become rich by their own genius and unwearied industry: not one out of every hundred thousand of those in the interior having ever seen the ocean, and knowing as little about England as the people of ancient India knew about Greece, Babylonia, and Macedonia when Alexander made his celebrated march across the Panjâb. Nor, indeed, are the descriptions of its civilization, wealth, and refinement, as given to us by occasional travellers who have penetrated the interior, wholly unlike those Arrian has handed down to posterity, with reference to the great cities of ancient India.

The Yang-tse-Kiang.

If my readers will take the trouble to glance

over a map of China and trace the windings of the great Yang-tse-Kiang to its outlet near Shanghai, they will see the extent of territory watered by this mighty stream, together with its various navigable branches. Rising in the southern slope of north-eastern Tibet, and, thence, flowing to the south-east, the Yang-tse at first passes through a country of lofty snow-covered mountains, the drainage of which in warm weather largely increases the volume of its waters, and produces at the same time, in great measure, the vast floods which, in the months of July and August, inundate the widely extending valleys near Hankow and the lower portions of the river.[1]

Its source and extent.

From these mountain ranges, the Yang-tse winds its way through others of less magnitude and through fertile plains for 800 miles to Chong-kin-foo, forming the northern boundary of the provinces of Yunnan and Kweichow, and greatly increased in its volume by various tributary streams, two of which are of considerable magnitude. Through the province of Szchuen its course extends, for many hundred miles, in a north and north-easterly direction. Thence, passing onwards through numerous gorges and passes, at present altogether unnavigable, it debouches on the plain of Hupeh, where it is about half a mile in breadth; thence again, it proceeds for about 250 miles to Yo-choo-foo, at the Lake Tongting, where the upper Yang-tse ends, and where the lower or greater river of the same name, commencing its course, passes the important city of Hankow, receiving near this city

[1] See an interesting paper on the inundation of the Yang-tse-Kiang, by E. L. Oxenham.—Report of the Proceedings of the Royal Geographical Society, 1875.

the waters of the Han river, its greatest tributary, and the Chin-kiang: at this place, it is a mile and a half wide, but, at its mouth, near Shanghai, the Yang-tse extends to a width of 12 miles, its whole course being upwards of 3000 miles in length.

This great river is subject periodically to floods, some of these, as that of 1870, converting the country for miles on either bank into a vast sea submerging many villages, whose position can only be traced by the roofs of the houses, as the highways are by the tops of the willow trees lining them.

In February 1860, the Yang-tse was for the first time opened (by treaty) to the ships of other nations; and one of my own, the *Scotland*, an iron auxiliary screw steam-ship of about 1100 tons gross register, commanded by Captain A. D. Dundas, R.N., was the first foreign merchant-vessel[1] which loaded a cargo from Shanghai to Hankow,[2] bringing back teas for transhipment to Europe and America; but it was not until 1863 that any English vessel loaded a cargo direct from Hankow for Great Britain. On the 8th May of that year, another of my auxiliary steam-ships, the *Robert Lowe*, of 1250 tons, commanded by

Opened to trade, 1860.

First steam-ship direct from Hankow to England, 1863.

[1] When, in September 1858, the question arose as to how far it was possible to declare the River Yang-tse navigable for Europeans, the late Admiral Sherard Osborn undertook to test it by taking Her Majesty's ship *Furious*, which he then commanded, accompanied by the *Cruiser* and two gun-boats, up the river as far as she would go. He was the first to navigate a foreign ship of any kind to Hankow, and the service he thus rendered was a very important one, for it enabled Lord Elgin to insist on this great river being opened to foreign commerce.—See address at the anniversary meeting of the Royal Geographical Society by its President, Sir Henry C. Rawlinson, 24th of May, 1875.

[2] The *Scotland* sailed from Shanghai with a full cargo for Hankow in June 1860. She drew 17 feet of water. Two light-draught trading steamers preceded her: one an American river-boat, and the other a Russian vessel from the Amoor.

William Congalton, left Shanghai for Hankow for the purpose of loading a cargo of teas direct for London: two other English vessels had, however, preceded her.

Passage of the *Robert Lowe* and her cargo.

The navigation of this river was then very little known, and there were many difficulties to encounter which have since been removed; under these circumstances, and as the engines of the *Robert Lowe* were only 80 nominal horse-power, her passage between Shanghai and Hankow, a distance of 608 miles, occupied ten days: one day, however, was lost in changing her propeller, while she had to anchor every night. The current against her averaged three knots an hour, but in some parts ran fully five knots. The least depth of water (the river being then at its ordinary height) found by soundings was $4\frac{3}{4}$ fathoms on the bar of the Longshan crossing: the average depth being from 8 to 9 fathoms, but, in many places, Captain Congalton did not obtain soundings at a depth of 14 fathoms, and, in long reaches, where the waters were contracted, the depths were from 20 to 30 fathoms.

At Hankow, where the *Robert Lowe* anchored to receive her cargo (about 300 yards from the bank), the depth of water was 14 fathoms, with a current running at the rate of $3\frac{1}{2}$ knots an hour. The new teas generally arrive in boats (chops) about the 10th of June, and, on the 23rd of that month, she sailed with a full cargo[1] for Shanghai and London. She was fifty-seven hours under weigh on her pas-

[1] The cargo of the *Robert Lowe* from Hankow for London consisted of 9568 chests, 234 half chests, and 2064 boxes of black (Honor) teas; 535 bales of cotton, 192 packages of sundries. Her freight amounted to 10,315*l*., and 480*l*. passage money.

sage from Hankow to Shanghai; the current, the river being then fuller, running at from four to, in some places, seven knots an hour.

In 1863–4 there were nine steamers employed trading between Hankow and Shanghai, five British and four American, some of these having a capacity for 2000 tons of tea, and all of them vessels of great speed. Sailing all night as well as during the day, they, in fine weather, made the passage to Hankow in four days, returning under favourable circumstances in less than half that time. Freights then ranged either way, from 3*l.* to 4*l.* per ton, treble what they are now, but the current expenses were very heavy, arising from the high price of coal, an increased scale of wages, and exorbitant port charges. Since 1864, the trade has greatly increased both in goods and passengers, large numbers of emigrants are now conveyed in the steamers from the interior to the coast, whence they embark for voyages, many of them so distant as California, the Mauritius, and the West Indies.[1]

Number of steamers employed on the Yang-tse, 1864;

and in 1875.

[1] It may, however, be stated that the chief emigration is from the southern parts of China, and, rarely, north of Amoy. This, on the whole, is a well-regulated trade, and generally carried on in British, American, and German ships, specially chartered for the purpose; all of which, while thus engaged, are under the Hong-Kong Passenger Act, which has been adopted by the consuls at the different Treaty ports. The coolie trade from the Portuguese settlement of Macao, with which it is sometimes confounded, is of an entirely different character, and resembles much more the old and iniquitous slave-trade than free emigration. At Macao and in its vicinity, the coolies are collected, often in large numbers, by coolie-brokers, who are, invariably, men of very questionable, if not of the most depraved, character. These scoundrels, for the most part Chinese and Portuguese, stow these poor creatures away in well-guarded barracoons, ready for shipment; many, perhaps, most of them, not knowing for what purpose they have been collected. Some of them have been actually sold by

S. S. *Hankow.*

There are few finer steamers to be found in any part of the world than the *Hankow* [1] (belonging to Messrs. Swire and Company), now employed in the trade of the Yang-tse. (See illustration, page 471.) Steamers of her type now leave Hankow and Shanghai daily—one despatched by Russell and Company, the other by Butterfield and Swire, by whom the bulk of the carrying trade between these places is now conducted in steamers.

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their relatives to the brokers, or decoyed away from home by false representations; indeed, cases might be produced, where fathers have even staked their children and themselves at gambling-tables, and, on losing their stake, have been, summarily, transferred or exchanged for their price in coin to these still more depraved dealers in human beings. The most usual destination of these unfortunate creatures is Peru, where they are employed on the Guano Islands, and from which, alas, they seldom return.

Her power and capacity

[1] The *Hankow* and three other steamers of a similar class were built for Messrs. Swire by Messrs. A. and J. Inglis of Glasgow, expressly for the trade of the Yang-tse; their dimensions are as follows:—

	Pekin and *Shanghai.*	*Ichang.*	*Hankow.*
Gross tonnage	3076	1781	3168
Length on load-water line	292 feet	242 feet	308 feet
Breadth, moulded	42 „	36 „	42 „
Depth „	15 „	12 ft. 6 in.	16 „
Load draught	10 „	9 feet	11 „
Dead weight capacity	664 tons	460 tons	840 tons
Measurement capacity in tons of 40 feet	3668	1972	3800
Passenger accommodation, Europeans	14	10	14
„ „ Chinese, 1st	16	6	18
„ „ Chinese, 2nd	164	106	170
Speed on trial	13 knots	12 knots	12¾ knots
Diameter of cylinder	68 inches	62 inches	72 inches
Stroke	12 feet	10 feet	14 feet
Indicated horse-power	1450	1200	1840
Pressure of steam	27 lbs.	33 lbs.	35 lbs.
Consumption of fuel at full power (per hour)	33 cwt.	27 cwt.	40 cwt.

The *Pekin* was finished in May 1873; the *Shanghai* in July 1873; the *Ichang*, October 1873; and the *Hankow* in April 1874.

The hulls of these vessels are of iron to the main-deck, and of

Chinese Steam Navigation Company.

But the most interesting fact connected with the maritime progress of the Chinese has been the establishment of a line of steam-ships by a company of Chinese merchants, and under their own flag.

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the most substantial construction, every precaution being taken to give them sufficient strength to make the voyage to China in safety, as well as to withstand the severe strains they are occasionally subjected to in the river, by being left aground with a full cargo. The *Hankow* cost, delivered at Shanghai, close upon 70,000*l*.

In forwarding the particulars of these vessels, Messrs. A. and J. Inglis remark: "Though the hulls are constructed entirely of iron, the entire structure above the main-deck is of wood, as light as possible consistent with the requisite strength, so as to lessen the top weight, as we were informed that the steamers of the Yang-tse were peculiarly liable to get aground, owing to the frequent shifting of the channel in some parts of the river. The cargo spaces," they add, "are in the lower holds, and also between the main and saloon decks. The accommodation for passengers and officers, the galleys, pantries, bath rooms, store rooms, and other conveniences are all above the saloon deck.

"The main saloon is placed forward between the captain's rooms and the machinery space; above the captain's rooms are the pilot-house and quarter-masters' cabins.

"The engines are after the American style, with walking beam, but are rather more solidly constructed than is usual in America. The gallows frame, which supports the main centre of beam, instead of being made of wood as in the States, is of malleable iron; box framing is secured to massive box keelsons on the floors of the ship. This style of framing, never before adopted in beam engines, has given great satisfaction in the six steamers to which we have fitted it.

"The *Ichang* and *Hankow* had common radial wheels, but in the *Pekin* and *Shanghai* feathering wheels were adopted, with marked advantage in point of speed. We have no doubt that the Hankow would have attained 15 knots speed, had she been fitted with feathering wheels.

"Besides these four vessels we built a similar vessel, the *Hupeh*, for Messrs. Russell and Company, Shanghai, in 1868, and the *Shing-King*, a sea-going steamer with beam engine, in 1873. Messrs. Russell and Company had previously built all their steamers in America or China, but, becoming alive to the advantages of iron over wooden hulls, had the above vessels and three screws built by us for their trade on the Yang-tse and Gulf of Pechili."

Although shares are held by the Chinese in many of the other steamers, it is worthy of note that the vessels of this company are owned almost, if not exclusively, by them. But it is still more remarkable, that a scheme for a Chinese naval reserve is now being arranged in connection with the "China Merchants Steam Navigation Company."[1] It is proposed that each of the larger provinces shall furnish two steamers, and the smaller provinces one, to be added to the fleet of that company, and employed by it while the country is at peace, but to be at the service of the Imperial Government in the event of war.[2] This undertaking, which would appear to have received the approval of the Emperor, will, when complete, consist of twenty-eight steamers, one of which, it is said, has been already ordered in England. It will be, indeed, an era in the history of China when an ancient nation, so exclusive and conservative, substitutes for its junks[3] the steamships of modern nations alike for war and commerce.

[1] *North China Herald*, 21st of January, 1875.

[2] The Chinese Government have during recent years established various very extensive arsenals, especially at Nankin, Foochow, and at Shanghai, where they manufacture large quantities of small arms, and various kinds of machinery. At the two latter places, they are now building gun-boats and war cruisers, and they contemplate, also, constructing iron-clads at these places.

[3] Chinese junks vary in size from 120 to even 1000 tons, but, as they stand high out of the water, their capacity seems greater; they are usually fitted with two or three masts, and their sails are furled or unfurled like Venetian blinds. Those built and equipped for war are somewhat superior in strength and in speed to those employed in commerce; but, in general, the decoration and design are similar. The merchant vessels are provided with ports, so as to carry guns. The most remarkable features in their hull are the abrupt and flat termination of the bow, together with the absence of a bowsprit. A strangely fashioned contrivance answers the purpose of a

Proposed imperial fleet of steamers.

As there is perhaps no more interesting incident in the history of merchant shipping, than the change now being made in the vessels of the Chinese Empire

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windlass. It is affixed to the outside of the bow, by means of which the anchor is weighed. As among the ancients, an eye is sometimes painted upon the bows of their war junks. The lower part of the stern is either entirely hollowed out, in an angular form, or, being flat in its primary construction, has in its centre a recess of that description. Within this, is a second hollow or chamber, rising the whole height, nearly from the keel to the bottom of the quarter gallery, within which the rudder moves, and is protected from the violence of the sea. This rudder is 5 or 6 feet in length, and managed by ropes only, one of which is fastened to the poop, so as, occasionally, to lift it out of the water, with a view to its preservation.

But the Chinese have another, and much more ornamental description of sea-going vessels called the "Soma," with (see illustration, p. 475) usually only one mast: and, with these vessels, the Chinese sail along the coasts of Batavia, Manilla, Annam, Cochin China, Cambogia, Chinchiu. They are capacious for their tonnage and will hold about a thousand chests of tea. They are high and round on each side, the rudder is slender and can be taken out with very little difficulty. They have no upper sails, but only one great fore-sail, besides the sprit-sails, and the mizen, all of which are made of mats tied together across bamboo sticks. They lower the sails with difficulty, and to effect this are generally obliged to send a sailor up the mast to tread the yard down.

All Chinese sea-going junks are armed with cannon — some of them heavily for defence, and when it suits their purpose for attack, as too many of them, though professing to be honest traders, become pirates whenever a fitting opportunity offers. Numerous instances might be given of these marauding attacks upon the defenceless trading vessels of all nations, especially when a rich booty is anticipated. In such cases, their practice is to sail to windward of their prey, sheer alongside and, if the weather permits, throw from the mastheads "stink-pots" on board of their victims. The atrocious smell from these pots is certain to clear the decks and drive the crew below so that the Chinese can thus, generally, obtain a footing on board without opposition. Except when resistance is offered, the lives of the crew of the merchant-vessels are generally spared; but there have been many instances when all on board have been massacred, when the most revolting scenes have occurred, and when the ships have been scuttled and sunk with all on board. As a rule, however, these pirates, if they obtain what they require, leave the plundered ship and crew to their fate.

the following drawing of one of their finest tea-boats ("soma")[1] may not be uninteresting to my readers; the more so, as I have reason to believe that vessels

CHINESE TEA-BOAT.

almost as perfect and ornamental as this one might have been found navigating the coasts and rivers of China even before the dawn of history, and, that they

[1] The whole of the native craft of China, above a certain size, are usually described as junks, and the name of this particular description is, comparatively, modern. Charnock and other writers have puzzled themselves to know why they are called soma or sommes. Soma in Portuguese signifies cargo or burthen, and the French have the same meaning, *bêt s. de somme*, beasts of burthen; so that soma or sommes as now applied to these vessels, simply means vessels of large cargo capacity, and is not, as Charnock supposes, a corruption of any Chinese word.

have remained almost unchanged till now, when they are about to be displaced by the steam-ships of Europe, is an event of unusual significance in the progress of ancient nations.

Increase of trade with China.

Though our export trade with China has of late years materially increased, a still greater increase may be anticipated if steamers are placed on the upper waters of the Yang-tse, and still more so if Europeans are allowed to trade direct with the dense population of the interior. That such results may be hoped for is clear from the fact that, wherever the merchants of Europe and America have settled, Chinese merchants have been greatly enriched by this intercourse; they have, in fact, found, as the Germans did when the Hanseatic League commenced their exclusive commercial operations in Europe centuries ago, that new traders brought with them new sources of wealth, and developed channels of trade hitherto unknown or at least unrecognised; a result naturally to be expected in a country, such as China, producing within itself, and in extraordinary abundance, some of the most valuable articles known to commerce, at a comparatively small expenditure of either labour or capital. Thus, silk, in most of the provinces of China, is produced by the labour of the women and children alone, the trees occupying the place of no other crops. *Insect* wax, another article of a high marketable value, is also produced at a trifling expense; while the opium crops of the interior probably cost less in labour than any other that has to be annually sown and reaped.[1]

The resources of the interior.

But beyond these, China produces in vast abun-

[1] See Report of the Delegates of the Shanghai General Chamber of Commerce on the trade of the Upper Yang-tse, 1869, a most interesting and instructive document published at Shanghai.

dance numerous other articles, necessaries as well as luxuries of life, in great demand in every part of the world. Apart, for instance, from the staple article, tea, which no civilized nation can now dispense with, and silk, which increases in demand with the wealth of nations, and is even more sought after now than it was when the Roman Empire had reached the plenitude of its grandeur, the western provinces of this much more ancient empire, especially that of Szchuen, produce rice and other grain crops in astonishing natural luxuriance, and these would be cultivated to a far greater extent than they now are, if increased facilities were afforded for their export. Already tobacco, sugar, hemp, and tung oil, are sent to the coast in large quantities from Szchuen, and form, even without the means of interchange with foreign nations, a source of ready-made wealth as the mere bounty of nature. Hence, the inhabitants are generally rich, except in districts where the population is too dense, or where they are exposed to undue extortion, owing to the avarice of the authorities. In Szchuen, as also in Yunnan and in many other provinces, the agricultural population is well off; the farms are large; the heads of families being as well dressed as merchants in great cities; the women too, as a rule, are "richly attired, and the appearances of many of the rustic villages and large farms convey the impression of a perpetual holiday."[1]

"Coal is worked on the hills in the neighbourhood of Chungking, and affords employment to the people of the villages, who make a kind of patent fuel of it,

[1] Report, p. 3.

for which they find a market at Ichang, as well as in the smaller towns in the neighbourhood."[1] Cotton is also produced in abundance; and "among the agricultural population of Szchuen, the women and children, as well as old men, employ themselves in spinning and weaving it, not only for their own wants but also for sale in the towns."[2] "The people of Chungking," the delegates state,[3] "expressed great readiness to trade with us, and seemed surprised that we did not bring goods for sale. Foreign merchants will undoubtedly be well received whenever they may choose, or be permitted, to go there."

Mode of conducting business.

The native merchants of the interior of China appear to be keen traders; but, probably, it would be necessary for foreigners, in their first intercourse with them, to do their business through the established *hongs*, who are united in powerful guilds, resembling those so general in Europe, a few centuries ago, with a similar reputation of tyranny over all smaller dealers, and a tenacity in everything affecting their own privileges. Nearly all the important branches of trade in the interior are now under the control of these guilds, or associated *hongs*, who are responsible to the authorities for the duties leviable, with a power of regulating particular trades recognised by the Government.

"Hongs" or guilds.

It is curious to find in distant parts of the world, so remote, indeed, that the inhabitants know nothing of any portion of the globe beyond the confines of China, nor, with rare exceptions, have ever heard of any country but their own, the same rules for the regulation of commerce as were general throughout Europe

[1] Report, p. 14. [2] Ibid., p. 17. [3] Ibid., p. 19.

in the sixteenth and seventeenth centuries;[1] even their banking system having much resemblance to that of Europe. In China, the custom prevails of making large deductions from the weight or nominal price of goods, for cash payments; the ordinary credit, according to ancient habit, being from six to twelve months, or even more. Negotiation of drafts is managed by bankers, mostly by Shansi men, who profess relationship with every important place in China, as the Lombards once did in Europe. Chinese bankers.

Prior to the Tae Ping rebellion, Hankow claimed to have a complete, and, by all accounts, a wealthy banking system, the smallest of the banks, called Yin-hongs, having subscribed capitals of many thousands, while the Shansi exchange-houses (Piaw Hoo) counted their wealth by hundreds of thousands. At that time, a great deal of the spare capital of the north found its way to this city, where it was lent at rates not greatly in excess of those now current

[1] As the merchants resident in the interior of China had no intercourse with, nor, in fact, any knowledge of, Europe till a comparatively recent period, it may be inferred that such guilds are of the most remote antiquity, if not of pre-historic times; and although no mention is made of them in the early records of the Chaldeans, Assyrians, Phœnicians, or Egyptians, it is quite probable that similar customs prevailed among the earliest of those nations, and were interchanged by them in their commercial intercourse with the Chinese on the one hand, and with the Europeans on the other.

My learned friend Sir P. Colquhoun is of opinion that we got our guilds (not corporate bodies, as they became afterwards, but associations of men similarly employed like the present trades' unions), which existed in England as early as the ninth century, from the East, through the Teutonic tribes who came from the north of Europe. He adds, that the word "Zunft," German for "corporation," is also possibly derived from the Arabic plural word "Esnáf," a view which Mr. Redhouse supports: other Oriental scholars, however, whom I have consulted, see no reason for its derivation from the Arabic.

in England; but, during the rebellion, the Shansi exchange houses withdrew their capital, while the mandarins made such heavy levies on the smaller banks, that most of these establishments were closed, and "cash shops" were, for some time, the only medium of banking operations. These, however, have now assumed more important functions than that of mere exchange, and two of them have become, though still retaining the name of cash shops, banking establishments of considerable importance. These banks frequently make the necessary advances to the growers of the teas produced in such abundance in this district, though the bulk of the capital employed in this now vast trade is provided by the English and American merchants, many of whom have houses at Hankow.

River and coasting trade of China.

Though the most valuable portions of the trade between Hankow and the sea-coast is now conducted by steamers, native sailing-craft of various sorts are still the only means of water transport, on the upper Yang-tse, which is navigable for vessels drawing not more than eight feet of water as far as Ichang, 363 miles above Hankow. As many as 800 of these vessels, averaging about 50 tons each,[1] have been counted at one time in the harbour

[1] These boats are usually known by the name of *sampans*, and are generally used for the transport of commodities from the interior to Hankow, and sometimes to the coast. But they do not serve for commercial purposes only; they are used as dwellings for whole families or populations, who are born, marry, and die in them. In those employed for the conveyance of salt on the Yang-tse, the chief type of the Chinese art of shipbuilding may be seen in all its singularity. Their sides are mostly painted black. The upper portions of these craft are strengthened by broad but thin beams, which are painted in various colours, but most frequently in red, and, between these, the port-holes are represented in the middle of a square of a similar colour. Towards the bows the sides are raised, and form continuous cheeks,

of Shansi alone. Their crews, like the boatmen of the Nile, are a special class of men, trained to the service, whose forefathers, through many generations, have followed a similar calling. They are a hardy race, and manage their rude craft with considerable adroitness. Besides these, lorchas, under various foreign flags, running in competition with the steamers, find profitable employment in the conveyance of bulky and low-priced produce and merchandise between Shanghai and Hankow, while the river below the latter place is still frequented by large fleets of native vessels, independently of the crafts engaged in the salt trade, which make the short voyage to places above Ching-Kiang; sea-going junks also find their way up to Taiping and Woohoo.[1]

Soon after the opening of the trade to foreigners, the sea-going junks employed in the trade of the coast were opposed by small sailing-vessels from other nations, more especially from Germany and

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painted green, with an eye, or some other fantastic emblem, in the centre. The bow is quite flat; its width at the water-line, is usually from 9 to 12 feet; and, there being no stem or cutwater, the bow can only repulse the pressure of the water, without dividing it. The poop is raised, and open at the fore part, with a white scutcheon covered with paintings, representing flowers, dragons, or other allegorical figures.

[1] The tea boats on the Canton river and the Yang-tse are very numerous. They are clumsily built, and of various forms. Some have a high stern, ornamented with paintings of the brightest colour. The stern has usually a considerable rake, and the sides terminate with planks distinct from the hull, resting on a cross-beam. They are covered with varnish, and, as the heads of the nails by which they are fastened are pointed with mastic, the line of the ribs is not apparent Most of them are covered in with a round water-tight roof, over which an awning is sometimes spread. On both sides of the roofs are uprights with rails resting on a deck, sufficiently wide and long to pass to the stern. They have seldom more than one mast and one large sail.

the northern ports of Europe. Many brigs, schooners, and barques, of from 150 to 400 tons, were also sent from England to engage in the trade, but these, as well as the sea-going junks, are now in turn being displaced by steamers which traverse almost every part of the Chinese seas, as far as Japan, where some of them run in connection with the great English and American lines, and ere long they will, no doubt, cover the more remote inland waters of the Empire.

Japanese line of steamers.

But the Japanese, as well as the Chinese, have now various merchant steamers under their own flag; they have, also, their iron-clads, the first of which was built by Hall, of Aberdeen; and they own the *Stonewall* (originally built in England for the Confederate States), which they used to advantage in their civil war of 1868–69. Their first steamer of any kind was the *Emperor* yacht, presented to them by Lord Elgin on the occasion of making the commercial treaty in 1858–59. Unlike their great neighbours, the Chinese, who were slow to adopt European customs, and who for ages preferred their clumsy junks to the finest sailing-vessels of the East India Company, the Japanese have, since 1859, become owners of steamers with astonishing rapidity; a fact the more noteworthy, that, though their country presents many inducements to maritime pursuits, their native population do not seem at any period of their history to have been a maritime people. Indeed, they were not encouraged by their laws to become so. On the contrary, they were restricted to both form and size in the construction of their junks, with the object, it is presumed, of prevent-

ing their leaving Japan for foreign countries; hence these vessels are, as a rule, the rudest of sea-going craft. Invariably rigged with a single mast, and one great square sail which reefs down, curtailed, when required, by the lowering of the yard; they are, however, sometimes to be found encountering, in these unwieldy craft, heavy gales, and at unexpected distances from home.[1]

But the eyes of the Japanese have been recently How employed.

[1] In the best class of these vessels, the cabin projects from the ship about 2 feet on each side, and there are folding windows round it, which may be opened or shut as pleasure or occasion may require. In the furthermost part are the rooms for passengers, separated from each other by folding-screens or doors, with the floors covered with fine mats. The outer cabin is always considered the best, and is accordingly assigned to the most distinguished passengers. The roof, or upper deck, is flattish, and constructed of neat boards, curiously joined together. In rainy weather, the mast is let down upon the upper deck, and the sail extended over it for the sailors and the people employed in the ship's service to take shelter under it, and to sleep at night. Sometimes, the better to defend the upper deck, it is covered with straw mats, which, for this purpose, are kept at hand. There is but one sail, made of canvas, and very large; and one mast, standing up about midships, but somewhat towards the stern. This mast, which is of the same length as the ship, is wound up by pulleys, and again lowered upon deck when the ship comes to anchor. The anchors are of iron. Ships of this burden have commonly thirty to forty hands to row them, if the wind fails. The rowers' benches are towards the stern. They row in unison with the air of a song, or tune with words, which serves at the same time to direct and regulate their work, Their mode of rowing. and to encourage each other to exertion. They do not row after the European mode, extending their oars straight forwards, with the blades just below the surface, but they let them fall down into the water almost perpendicularly, and then lift them up again. This way of rowing not only answers the same purpose as our own, but is performed with less labour, and seems to be more adapted to circumstances, considering the narrowness of the passage through which ships sometimes pass, or when vessels pass each other, or when the benches of the rowers are raised considerably above the surface of the water. The oars are made in a peculiar manner, suitable for this mode of rowing, being not all straight, like the Europeans' oars, but somewhat bent.

opened to the advantages of foreign trade,[1] and they are moving onwards in a manner which could hardly have been anticipated from what is known of their previous history; indeed, they have recently (February 1875) announced the establishment of a regular line of steamers under the Japanese flag. The shares of this undertaking, which they have named the "Mitsu-Bishi Steam Navigation Company," are held almost, if not exclusively, by Japanese. This company already possesses four steamers, the *Tokio-Murin* (late *New York*), the *Kunayana-Murin* (late *Madras*), the *Takar-Murin* (late *Acanthia*), and the *Zazon*, while others are in course of construction in Great Britain, which are to form a "weekly line" between China and their own ports of Nagasaki, Hiogo, Imioseki, and Yokohama.

[1] In January 1861, I sold to the Prince of Satsuma one of my auxiliary steam-ships, the *England*, which had been employed in trade between India and China, and had made one or two voyages to Japan, soon after the ports of that country were opened to the vessels of foreign nations. Captain A. D. Dundas, R.N., who commanded her, and was a part owner with me of this ship and of a sister-ship, the *Scotland*, which afterwards became the property of the same prince, informs me he is under the impression, that the *England* was "the *first* foreign vessel purchased in Japan, except by the Government proper." If so, her sale may be considered the introduction of the thin edge of the wedge which has rapidly led to a very general introduction of foreign bottoms. As an instance of the remarkable skill and ingenuity of the Japanese, they made new boilers of copper for this ship, within twelve months of the time when she came into their possession (I believe they had never before seen a boiler), but I am uncertain whether these boilers were ever fitted into the ship. If they were, I fear the small pieces of copper of which they were made (Japanese mechanical knowledge not having as yet learnt the art of constructing plates of the necessary size) would render them useless. The *England* was seized and scuttled by the British fleet in August 1863, at the time of the bombardment of Kagosima, and, having been sunk in very deep water, was never raised. The *Scotland* was still in the service of the Japanese in 1870.

What an advance on the rude craft of which the following is an illustration![1]

When we consider the enterprising character of the Japanese, we cannot but feel surprised that such vessels as this clumsy hulk, should, in spite of their restrictive laws, have been found sufficient for all their wants, and that through countless ages. But now the spirit of progress in maritime affairs guides their councils, and though, at present, their steamers are commanded by Europeans or Americans, and have foreign engineers, in other respects they are manned by Japanese. Ere long the junks, alike of China and Japan, will be things of the past, strange toys to the children of these countries, as they have long been to the children of Europe.

[1] Though the above drawing represents one of the largest of the Japanese junks, she, like all the others, had only one mast, its place being opposite the vacant space shown at the gangway. The apparent bulwark of trellis-work before this gangway is meant to break the sea and allow the water to wash through. Besides, as nearly all the junks carry deck cargoes (covered with water-tight mats where perishable) the gratings serve the purpose of protection to the goods thus stowed, and afford facilities for lashing and securing them in their places on deck.

CHAPTER XIII.

Eastern Steam Navigation Company—Detailed proposals of the directors—Capital subscribed to build the *Great Eastern*—Relative size and speed of sailing-ships—Mr. Brunel proposes to build a ship five or six times as big as any existing vessel, and is supported in his views by Mr. Scott Russell—Plan of construction, size, &c.—Mr. Atherton considers the views of the directors are not supported by their data—The *Great Eastern* commenced May 1, 1854—Details of her dimensions and mode of construction—Practically, one ship within another—Compartments and bulkheads—Floor—Construction of the iron plates for hull—The deck and its strength—Enormous steam-power from combination of paddle and screw—Paddle-wheel, auxiliary, and screw-engines—Donkey-engines—Proposed accommodation for passengers, &c.—View of deck, &c.—Saloon—Intended to carry twenty large boats and two steamers—Compasses—Size of sails—Magnetic apparatus of Mr. J. Gray—Apparatus for steering—Rudder and anchors, and *note*—The ship itself a marvel though, commercially, a failure—Preparations for, and details of, the launching of the *Great Eastern*.

Eastern Steam Navigation Company.

In tracing the progress of steam navigation to the East the various tenders for the conveyance of the East India and Australian mails have been incidentally noticed. Among those which were lodged, in reply to an advertisement from the Admiralty issued on the recommendation of Lord Jocelyn's Committee of 1851, there was one from a new undertaking—the Eastern Steam Navigation Company—offering to convey the mails from Plymouth to Sydney and to the East Indies, &c., monthly, viâ Alexandria, in

vessels of from 1300 to 2100 tons, with engines of from 400 to 600 horse-power.[1] This company had been incorporated by royal charter with a nominal capital of 1,200,000*l.* in 20*l.* shares, having power to increase it to 2,000,000*l.* The projectors of the proposed undertaking were, in the highest degree, respectable, comprising some men of great wealth, and others of well-known scientific attainments. They were, in every way, competent to carry out the service they had tendered to perform. The general impression, at the time, seemed to be that they intended to act in concert with the Austrian Lloyd's Steam Navigation Company, a well-known undertaking trading from Trieste to different ports in the Mediterranean and represented in London by the late Mr. Joseph Edlmann, a merchant of the highest standing, whose name appeared as one of the directors of the new undertaking. But, as the ships the company intended for the service to India and Australia were not mentioned, and more especially as the directors did not state in their tender the sum they required for the performance of the latter service, their offer was not accepted, though it may have been considered.

Detailed proposals of the directors.

After the directors had communicated to the shareholders the result of their tender, some of them, on the suggestion of Mr. I. K. Brunel, recommended the construction of a steam-ship of extraordinary dimensions to trade with India. On looking at the export and import trade of Great Britain they observed that the main line of commerce passed round the Cape of Good Hope towards India, China,

[1] See Appendix to Report of Committee, 1851.

and Australia, following nearly the same track as far as Ceylon. On the fact of this great pathway of commerce they grounded, and not without plausible reasons, their scheme for the profitable employment of various vessels of gigantic size between England and Ceylon, from which place smaller vessels were to diverge to the other parts of India, as well as to China, Japan, and Australia; the intention, however, being to despatch their first great vessel, when ready, direct either to Calcutta, Sydney, or Melbourne.

Having made the calculations (to their own satisfaction) that such ships would maintain a speed of fifteen knots per hour, there was in their judgment no doubt that they would "attract so large a portion of the traffic as to afford full cargoes at remunerative rates both outward and homeward." The voyage from England would thus be accomplished in thirty days to Trincomalee, which had been selected for their central station, as it offered every facility for such a purpose. Thence they estimated that the voyage in ordinary steam-vessels could be accomplished to Madras in two days, Calcutta in four, Hong Kong in ten, and Sydney or Melbourne in fourteen respectively; the auxiliary steamers on these lines transferring the outward cargo from the leviathans, and bringing to them "the valuable products of all these countries as a back freight to England."

"Should the great ships," they said, "fulfil only the most moderate of the anticipations, in regard to speed, and be able to land goods in Calcutta within thirty-five days of their shipment in London, in Hong Kong

within forty, or in Melbourne within forty-four, it is certain that they will take up at higher freights a large amount of goods now conveyed in ordinary vessels. Of the whole Eastern tonnage, all that portion which will bear a minimum freightage of 5*l.* per ton, may be fairly calculated on as cargo available for their ships. Of such are the silks and silk piece-goods of India and China averaging from 2000*l.* to 3000*l.* per ton in value; indigo from 500*l.* to 1000*l.* per ton; tea, coffee, spices, lacdye, shellac, &c., of the value of between 100*l.* to 300*l.* per ton. Among the export goods intrinsically valuable enough to pay the higher rates of freightage may be reckoned the principal manufactures of Birmingham, Manchester, Sheffield, and Leeds: woollens, silks, satins, velvets, millinery, haberdashery, oilmen's stores, and hardware, besides the costly productions of France and Germany."

Going into various calculations in detail, they arrived at the conclusion that out of the exports to India there would be 180,000 tons of goods able to afford the minimum freight, without considering the goods at that time transported by the overland route in the ships of the Peninsular and Oriental Steam Navigation Company, the greater portion of which the directors of the great ship company felt certain they would secure, while they were, further, convinced that their ships would "attract a considerable portion of the exports to Australia were a line of branch steamers to be laid on from Trincomalee to the Australian ports."

The import trade, in the opinion of the directors, was even more valuable than the export, and could

"well afford a higher freightage in return for speedy transport." The Aberdeen clippers they said "obtain from 8*l.* to 12*l.* per ton for the carriage of fine teas from China, in which trade they will be utterly unable to compete with their great ships should they reduce the voyage from 80 to 40 days." Estimating at least 50,000 tons of tea from China should the freight not exceed 6*l.* or 7*l.* per ton, and, without considering the large and rapidly increasing amount of that article imported from Assam and the Himalayas, the tea from China in itself would be, in the opinion of the directors, an enormous source of profit. Then, should they reduce the voyage from Australia to 45 or 50 days, they might calculate with certainty on obtaining "the conveyance of all the gold from that country." In a word, they were of opinion that, after making the most ample allowance for working expenses, wear and tear, depreciation and insurance, "a surplus would remain equal to 40 per cent. per annum on the capital invested."[1]

Nor were the vast and increasing number of passengers overlooked in their calculations as affording a larger source of profit than even gold or merchandise, while, in their opinion, "for the transport of troops the capabilities of their ships would be such as always to command a preference from Government over vessels of smaller burden." Such were the views and calculations of the directors of the Eastern Steam Navigation Company.

Nevertheless, in spite of these glowing prospects,

[1] See Report of 6th August, published in the *Times*, 8th August, 1853.

many of the shrewd and more cautious shareholders in the original undertaking, including nearly all the persons interested in the Austrian Lloyd's Company, preferred receiving back the money they had deposited, on account of their shares, and declined to support the new company. Others, however, and among them many men of great capital and of high position in the world of science, consented, and, after considerable difficulty, sufficient capital was raised to construct the *Leviathan*, the largest ship ever known either in ancient or modern times, and the first, as well as the last, of the ships of this size they had contemplated building.

Capital subscribed to build the *Great Eastern*.

About this time the important question of increased speed in combination with increased dimensions was receiving the special attention of scientific men, and was discussed with great animation at the meetings of various associations. Mr. Charles Atherton, the chief engineer of the Royal Dockyard at Woolwich,[1] had taken the lead in forming public opinion on the novel problem of steam-ship capability. As regards *sailing-vessels* it had been observed that the average length of their voyages to Australia bore the following relation to their tonnage:

Relative size and speed of sailing-ships.

Tons.			
750 to 1000	took	140	days.
1000 to 1500	„	112	„
1500 to 2000	„	95	„
3000 and upwards	„	70	„

The inference drawn from these and similar observations, more or less founded on correct data, was that, to obtain high velocities in sea-going vessels, it

[1] Author of important works on "The Construction of the Steam-engine," and "The Capability of Steam-ships."

was merely necessary to make them large; it being argued that a mass of two or three thousand tons, once set in motion at a given speed, would overcome the resistance both of atmosphere and water with greater ease than a mass of half its weight. Mr. I. K. Brunel carried these opinions to an extreme length, and argued that there need be no limit to the size of a vessel, except what tenacity of material must impose. He further argued, from scientific theory and actual experience, that as the "tubular principle" provided the greatest amount of strength of construction with any given material, it, therefore, was possible to construct a ship of six times the capacity of the largest vessel then afloat, and one, too, that would steam at a speed hitherto unattainable by smaller vessels. Mr. Brunel, having originated this conception, communicated it, at the outset, to Mr. Scott Russell, and suggested the construction of a steamship large enough to carry all the fuel she might require for the longest voyage; and Mr. Scott Russell shared with Mr. Brunel in the merit of contriving the best method of carrying out these views. The idea of using two sets of engines and two propellers (screw and paddle) is solely due to Mr. Brunel, as was, also, the adoption of a cellular construction, like that at the top and bottom of the Britannia Bridge, in building the *Great Eastern*, the name this huge ship was now to bear.[1] These

Mr. Brunel proposes to build a ship five or six times as big as any existing vessel,

and is supported in his views by Mr. Scott Russell.

[1] As every important fact connected with the design and construction of this vast ship must prove of historical interest, I think it desirable to give an extract from the letter which Mr. Scott Russell himself wrote at the time on the subject, addressed to the editor of the *Times*, and which appeared in that journal on the 20th April, 1857:

"My share," says Mr. Scott Russell, "of the merit and responsibility

main characteristics distinguished the *Great Eastern* from all other vessels then afloat. Her model and general structure were in other respects identical with those of the ships built by Mr. Scott Russell, on the principle of the "wave line," which he had systematically carried out during the previous twenty years.[1]

Having obtained the requisite capital, the directors now concluded provisional arrangements for the construction of the screw-engines with Messrs. James Watt and Co., of the Soho Works, near Birmingham, and for the paddle-engines and hull with Messrs. Scott Russell and Co., of London. But, considering

Plan of construction.

is that of builder of the ship for the Eastern Steam Navigation Company. I designed her lines and constructed the iron hull of the ship, and am responsible for her merits or defects as a piece of naval architecture. I am equally responsible for the paddle-wheel engines of 1000 horse-power, by which she is to be propelled.

"But Messrs. James Watt and Co., the eminent engineers of Soho, have the entire merit of the design and construction of the engines of 1500 horse-power, which are to propel the screw.

"It is to the company's engineer, Mr. I. K. Brunel, that the original conception is due of building a steam-ship large enough to carry coals sufficient for full steaming on the longest voyage. He, at the outset, and long before it had assumed a mercantile form, communicated his views to me, and I have participated in the contrivance of the best means to carry them into practical effect. I think, further, that the idea of using two sets of engines and two propellers is original, and was his invention. It was his idea also to introduce a cellular construction like that at the top and bottom of the Britannia Bridge into the construction of the great ship. It will be seen that these are the main characteristics which distinguish this from other ships, and these are Mr. Brunel's. Her lines and her structure in other respects are identical with those of my other ships, which are constructed like this on a principle of my own, which I have systematically carried out during the last twenty years, and which is commonly called the 'wave' principle. In other respects, also, her materials are put together in the manner usual in my other ships."

[1] See article in the 'Encyclopædia Britannica,' 7th edition, on "Steam Navigation."

the novelty and magnitude of the undertaking, it may be interesting and instructive to review, still further, the grounds on which the projectors anticipated its success.

The ship, the directors said, "would be built in the Thames, to be completed in eighteen months; and would fulfil certain conditions, the most important of which was that she should not be obliged to stop at any place on the way to take in coal, stoppages for coal not only causing great delay by the time required for taking it on board, but compelling the vessels to deviate widely from the best route, in order to touch at the necessary coaling stations;" and, in avoiding the delay of coaling on the voyage, the ships would also escape the great cost of purchasing coals at a foreign station. "These ships," they added, "will carry, besides their whole amount of coals for the voyage (out and home[1]), upwards of 5000 tons measurement of merchandise, and will have 500 cabins for passengers of the highest class, with ample space for troops and lower class passengers. These the company will carry at rates much smaller than those of any existing steam-ships and, moreover, with an unprecedented degree of safety, comfort, and convenience which the great size of their vessels will

[1] Whatever may be gained by not requiring to stop at any intermediate port, I consider it a mistake, in a commercial point of view, to suppose any advantage is to be derived from taking on board a steam-ship, especially when engaged on distant voyages, sufficient coal to carry her out and home. The space the coals occupy in a steamer ought to be of more value, for the reception of cargo, than the cost of sending coals in sailing-vessels to the ports abroad where required, and than any loss sustained by the expense and detention of shipping them there.

afford." In thus increasing the size of their ships, the directors said, "they believed they were also obtaining the elements of a speed heretofore unknown: and if, hereafter, coals applicable to the purposes of steam navigation could be supplied from the mines of Australia, their carrying capacity both for cargo and passengers would be proportionately increased. The great length of these ships will undoubtedly, according to all present experience, enable them to pass through the water at a velocity of 15 knots[1] an hour, with a smaller power in proportion to their tonnage than ordinary vessels now require to make 10 knots."

Mr. Atherton considers the views of the directors are not supported by their data.

These views were, however, not allowed to pass unquestioned by many scientific men, and more especially by Mr. Atherton, who rejoined that, whatever pride the projectors might reasonably feel in the production of such an extraordinary vessel as the *Great Eastern*, the data relied on by them did not support their anticipations. He argued that, if based upon the performance of the *Rattler*, the size of the vessel that would be required for the due fulfilment of the conditions of the project, as announced by the directors, would, probably, be not less than 100,000 tons displacement, and that the whole capital of the company, as proposed in their prospectus would, probably, be much more than absorbed in the construction of a single vessel of the stupendous size indispensable for the performance of 25,000 nautical miles, without recoaling, at the average speed of 15 nautical miles per hour. As an engineer, Mr. Atherton was not opposed to the

[1] Equal to 17¼ statute miles.

construction of large ships, but he, like many other scientific and practical men, questioned the fulfilment of the mechanical conditions as respects the combination of a 15-knot speed with a 25,000-mile voyage without recoaling, on which the Eastern Steam Navigation Company had founded their project. Indeed, both practically and theoretically, he declared himself in favour of the superior capabilities of large ships as respected either speed or distance, but he forewarned the proprietors of the *Great Eastern* of the mercantile disappointment to which extravagant expectations, as to the combination of high speed and great length of voyage without recoaling, by the mere agency of size, would, in his opinion, inevitably lead.

The directors might, therefore, have seen that extreme caution was necessary for all mercantile steamship undertakings requiring the maintenance of so high a rate of steaming speed as they contemplated. Indeed, taking the actual results of the most successful steam-vessels of that day, it was more reasonable to doubt the realization of the hopes entertained by the projectors.[1]

The *Great Eastern* commenced, May 1, 1854.

Nevertheless, the sanguine expectations of the directors were in no way shaken and, under the advice and personal superintendence of Mr. I. K. Brunel, Mr. Scott Russell commenced the arduous undertaking in his yard at Millwall on the north side of the Thames.[2]

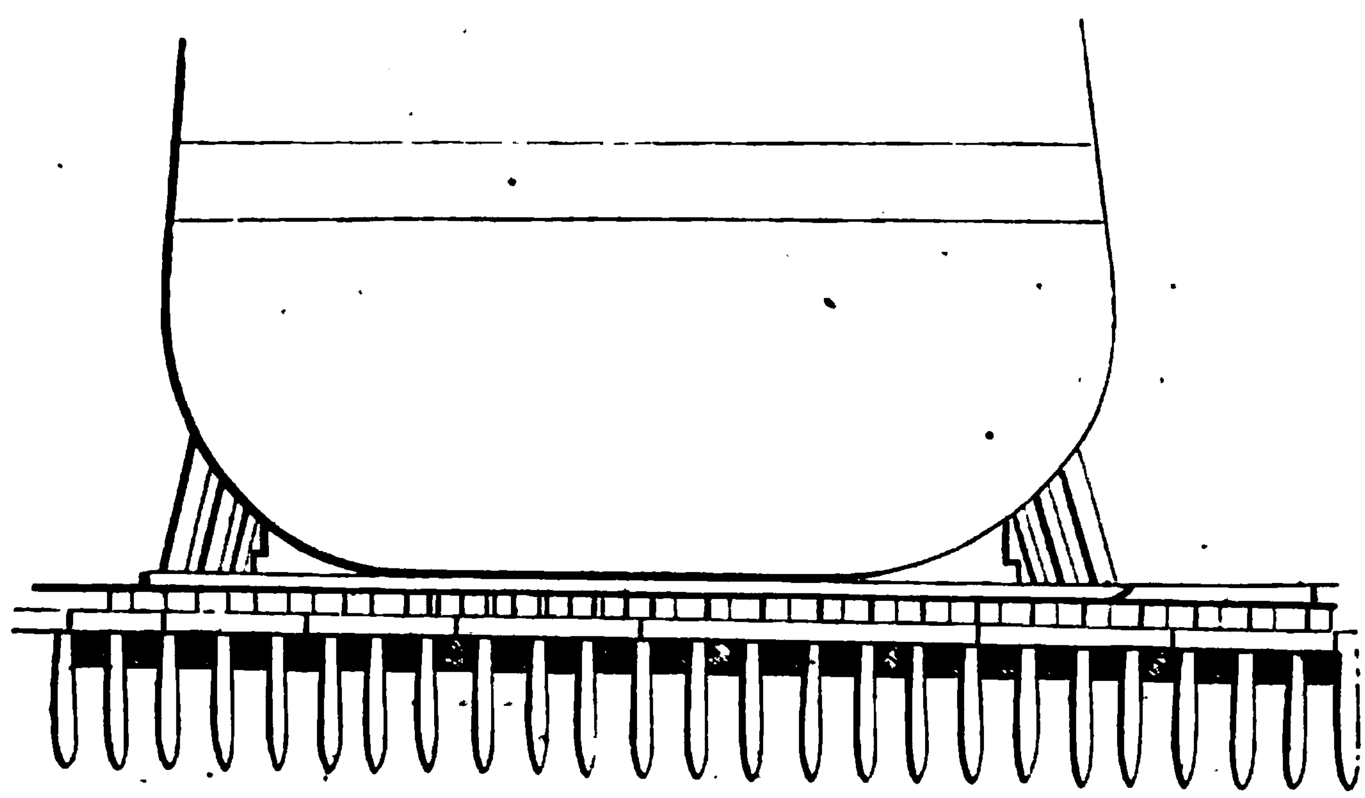
To prepare the ground for the reception of the

[1] I need not dwell upon these points, for which see *Times*, 28th February, 1854, and Mr. C. Atherton's note, 20th April of that year.

Details of her dimensions.

[2] The precise dimensions of the *Great Eastern* will be found with the Frontispiece illustrations.

enormous weight about to be placed upon it, 1500 huge piles of timber were driven through the loose surface soil into the more solid stratum below. These were girded so as to form a platform bound together by transverse and longitudinal balks of timber, between which thick beds of concrete were embedded, and, on this structure, *iron* rails were laid to form the launching ways, of which the following is the longitudinal section.



On this platform the first plates of the great ship, built entirely of iron, were placed, May 1st, 1854.

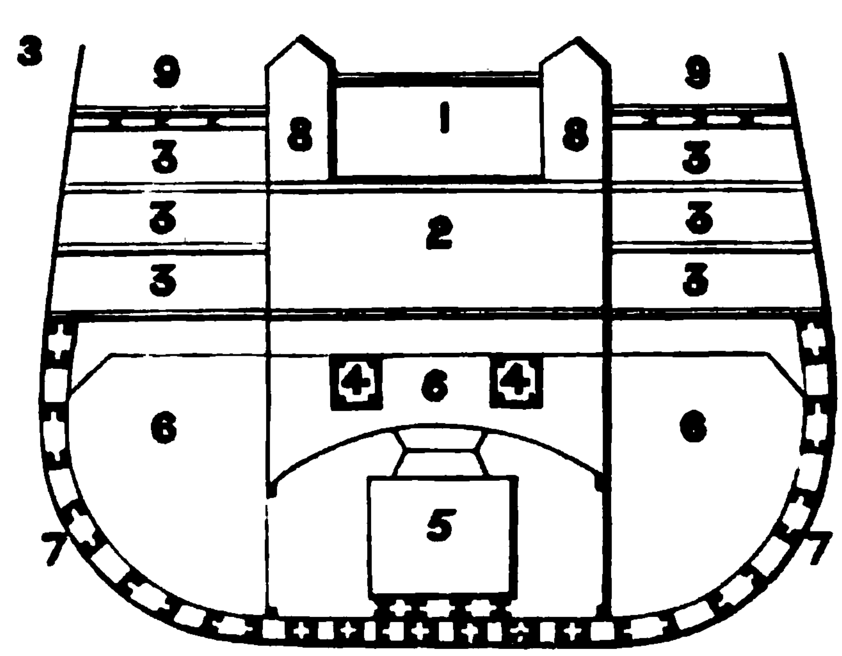
And mode of construction.

The hull of the *Great Eastern*,[1] which is of immense strength, is divided transversely into ten separate compartments of 60 feet each, and rendered perfectly water-tight, in all its parts, by bulkheads through which there is no opening, whatever, below the second

[1] I take the description of the vessel and everything relating to her from Mr. Scott Russell's "*Great Eastern* Steam-ship," H. S. Clarke and Co., Strand, London, 1857, the public journals of the period, the reports of the directors, and from my own observations at the time, as I more than once inspected the ship, when on the stocks and when afloat, for which every facility was afforded by her builders.

deck: two longitudinal walls of iron, 36 feet apart traverse 350 feet of the length of the ship. Instead of the usual keel there is a flat plate of iron in its place, about 2 feet wide and 1 inch thick, running the entire length of the vessel from stem to stern, and so set up as virtually to form part of the base on which all the rest of the fabric is raised, whether of plates or girders. The bottom and sides which ascend immediately from this keel plate are also 1 inch tapering to three-quarters of an inch thick, the entire structure having been raised from below by adding plate to plate upwards. These plates are fastened together by more than 3,000,000 rivets, each an inch in diameter, the whole being hammered in when at almost a white heat, and welded so close as to form parts of the plates which they bind together.

Practically, one ship within another. From the keel to the water-line the hull is double, having an inner and outer skin of the same thickness of iron, 2 feet 10 inches apart, between which, at intervals of 6 feet, run horizontal webs of iron



TRANSVERSE SECTION.

plates thus materially increasing the power of resistance both of the inner and outer skin. So far, therefore, as regards the portion of the vessel

immersed when laden, the *Great Eastern* is, practically, two ships, one within another, as may be seen by the transverse section, page 498, which exhibits the principle of her construction.[1]

The danger of a collision at sea is, thereby, greatly lessened, for if the outer skin is pierced, the inner one, remaining intact, as it would, except under very extraordinary circumstances, the safety of the vessel would not be endangered. Looking, also, at this arrangement in a commercial point of view, should the ship require ballast, the space between the outer and inner skin can be filled with water, so that whatever may be necessary in this respect can be obtained in a very economical and expeditious mode, to the extent in weight of 2500 tons.

Compartments and bulkheads. Besides the principal bulkheads, there is in each compartment a second intermediate bulkhead forming a coal bunker and carried up to the main deck, which can on an emergency be closed. Two continuous tunnels run through the principal bulkheads near the water-line in one of which the steam pipes pass, and, under the most improbable circumstances of damage to the ship, arrangements are made, so that facility and ample time would be afforded to close them leisurely, and to make them perfectly water-tight.

Floor. The floor of the ship is perfectly flat, the keel being turned inwards, and riveted to the inner skin. The bow and stern have additional strength

[1] The following references will serve more fully to explain the illustration of the transverse section of the hull of the *Great Eastern*: 1, upper saloon or main deck; 2, principal saloon in lower deck; 3, side cabins and berths; 4, tunnels for steam and water pipes; 5, boiler; 6, coal bunkers; 7, space between skins of ship; 8, skylights to principal saloons; 9, double deck.

imparted to them by strong iron bulkheads specially fitted to those parts of the ship.

Construction of the iron plates for hull.

Every distinct plate employed in the construction of the hull was moulded, beforehand, to the exact shape required by the situation it was to occupy. They were each gauged according to mathematical principles, wooden moulds being first prepared from the gauges, and the iron plates and angle iron accurately fashioned to correspond with the moulds.

10,000 tons of iron plates were used in the construction of the hull, or 30,000 plates (with about 100 rivets to each), each plate weighing on an average a third of a ton.

The deck, and its strength.

The deck of the ship is double or cellular, and is formed of two half-inch plates, at the bottom, and of two half-inch plates at the top, between which are webs of iron which run the whole length of the ship. The upper deck runs flush and clear from stem to stern for a breadth of about 20 feet on either side of the skylights and hatchways, thereby affording two magnificent promenades for the passengers just within the bulwarks; these promenades are altogether more than the eighth of a mile in length, as four turns up and down either side of them exceed a mile by 640 feet. Between the two side promenades of the upper deck are several quadrangular openings edged with low bulwarks, and looking down into the recesses of the structure. These openings are 42 feet wide, and nearly 60 feet long, the longest being 100 feet, and there are deck gangways connecting the side promenades between each of them. In these spaces the skylights of the large passenger saloons are fixed.

Enormous steam-power from combination of paddle and screw.

The distinguishing feature of the *Great Eastern*, in addition to her vast size, is the combined application of both the paddle-wheel and the screw. The engines are considerably larger than any previously made for marine purposes. There are ten boilers and five funnels, and each boiler can be cut off from its neighbour and used or not, as desired. The boilers are placed longitudinally along the centre of the ship, and are entirely independent of each other. Every paddle boiler has ten furnaces, and each screw boiler twelve furnaces, thus giving to the whole, the prodigious number of 112 furnaces. The funnels are each about 100 feet in length measuring from the floor of the boilers to the top of the funnel.

The paddle-wheel engines, of which the following is a transverse section, are a magnificent piece of workmanship, combining vast strength with great beauty and apparent lightness of design.

When these, combined with the screw engines (to which reference will presently be made), are at work

the mind is lost in wonder at the amount of mechanical power which is thus brought to play in the propulsion of one vessel, and the smoothness and harmony with which that duty is performed, in a space necessarily confined and limited, and amid the violent turmoil of the ocean. No work of art ever yet produced furnishes more exalted ideas of man's genius and skill than the unceasing and regular motion of these gigantic engines, especially, when we consider the tremendous shocks to which they must be at times subjected, and the delicate nature of some portion of the machinery, resting as this does, not upon solid granite as is the case with land engines, but on the ever straining ribs of a ship.

Paddle-wheel. The paddle-wheel engines have a nominal power of 1000 horses, they have four cylinders, the diameter of each being 74 inches, with a stroke 14 feet in length, giving 14 strokes per minute. Each cylinder with piston and piston-rod weighs no less than 38 tons, while each pair of cylinders with its crank, condenser, and air-pumps, forms in itself a complete and separate engine, and each of the four cylinders is so constructed that it can be, at once, disconnected when required, from the other three, so that the whole forms a combination of four engines, altogether complete in themselves, whether worked together or separately. The two cranks are connected by a friction-clutch by means of which the two pairs of engines can be connected or disconnected, by a single movement of the hand and at a moment's warning. All the engines are provided with expansion valves, and their combined force, when working 11 strokes per minute, indicates 3000 horse-power, with steam in

the boilers at 15 lbs. on the inch and the expansion valve cutting off at one-third of the stroke. But as all the parts of the engines are so formed and proportioned that they will work safely and smoothly at 8 strokes per minute, with the steam at 25 lbs. and fully open without expansion (beyond what is unavoidably effected by the slides), or at 16 strokes per minute, with the steam in the boiler at 25 lbs. and the expansion valve cutting off at one-fourth of the stroke, they can be made to give a power of 5000 horses. The paddle-shafts are each 38 feet long and weigh 30 tons, while the intermediate cranked shaft, 21½ feet in length, weighs 31 tons.

Two auxiliary high pressure condensing engines are fixed, adjacent to the paddle engines, for working the pumps and performing other necessary duties on board of the ship; these auxiliary engines are equal to 60 horse-power and can be worked to double that power if necessary. **Auxiliary,**

But the screw engines are even more surprising than those of the paddles: they are also of 1000 horse-power with four oscillating cylinders each 84 inches in diameter with 4-feet length of stroke and performing 50 revolutions per minute. They can work up to 4500 horse-power with steam in the boiler at 15 lbs. and revolving at 45 strokes a minute, the expansion valve cutting off at one-third of the stroke; but, with steam at 25 lbs., without expansion, and cutting off at one-fourth of the stroke, they can propel with a power of 6000 horses, so that the combined force of paddle and screw engines gives the tremendous power of 11,000 horses! The propeller shaft, in two parts, is 160 feet in length and **and Screw engines.**

weighs 60 tons, while the screw-propeller itself is 24 feet in diameter with 44 feet pitch. The paddle-wheels are, however, still more stupendous, being no less than 58 feet in diameter with a boss which alone weighs 16 tons, each wheel when complete weighing 90 tons.

Abaft the bulkhead of the screw engine-room are placed two auxiliary engines of 20 horse-power each for moving the screw-propeller, when the larger engines are disconnected, at such a velocity as will prevent the speed of the vessel from being retarded when the ship is under weigh with paddles alone, or when under sails and paddles.

There are, also, two auxiliary high pressure engines, each of the nominal power of 10 horses, for working the pumps, shafting, or other parts of the machinery, and for hoisting sails, taking in or discharging cargo, lifting the anchor, and for performing many other services usually carried on by the crew.

Donkey-engines. Each set of boilers is provided with donkey-engines, with independent boilers, and pumps of power sufficient to feed both sets of boilers, and are capable of being connected or disconnected, so that one donkey-engine may supply any set of boilers. These are each of about 10 horse-power.

Proposed accommodation for passengers, &c. This mighty vessel was destined to afford accommodation for 4000 passengers, viz., 800 first class 2000 second class, and 1200 third class, independently of the ship's complement of crew, amounting to about 400. The series of saloons, which were elegantly fitted and furnished, together with the sleeping apartments (as will be seen by referring to the longitudinal section in the frontispiece to this volume)

are situated in the middle of the ship and extend over 350 feet of her length.

As everything about this vast ship is really of historical interest, I present my readers (see frontispiece) with a view of her deck as seen from the bridge between the paddle-wheels, looking towards the stern, a sight which affords a more imposing appearance of her magnitude than any other view. The first skylight covers the passage to the engine-room and the captain's cabin, which is in itself a moderate-sized house, consisting of several rooms; behind it there are other two companions or staircases leading to the after saloons. As the old-fashioned speaking trumpet would be useless in such a ship, the captain signals his orders either from his cabin or from the bridge by semaphore arms during the day and by coloured lamps at night; while electric telegrams convey his wishes, not merely to the engine-rooms, but to other places below the decks where it may be necessary that his instructions should be instantaneously communicated. With regard to the main or upper deck itself, there is ample clear space to drill a full regiment of soldiers. View of deck, &c.

The lofty saloons and cabins are very imposing, differing as they do in most respects from those of ordinary passenger steam-ships, indeed, more resembling the drawing-rooms of the mansions of Belgravia of London or of the Fifth Avenue of New York. The one of which an illustration is furnished (page 506) bears the name of the "Grand Saloon." The illustration, however, shows only one half of this magnificent apartment, which is 62 feet long, 36 feet in width, and 12 feet in height, with a ladies' cabin, or rather Saloon.

GRAND SALOON OF THE "GREAT EASTERN."

boudoir, adjoining, 20 feet in length. Massive looking-glasses in highly ornamented gilt frames decorate its sides; the strong iron joists (beams) overhead are encased in wood, the mouldings being delicately painted and enriched with gilt beading. Around two of the funnels which pass through this gorgeous apartment are large mirrors, with alternate highly ornamented panels, and at their base are groupings of velvet couches. The columns (staunchions) which support the beams are richly decorated, while the iron work of the railings of the staircases leading to the lower cabins, or surrounding the open spaces necessary for more perfect ventilation, are, by some particular process, made to resemble oxidized silver, which is relieved by gilding. The walls (sides) are hung with rich patterns in raised gold and white, and at the angles are arabesque panels ornamented with groups of children and various emblems of the sea; other illustrations personify, in graceful forms, the arts and sciences connected with the construction and navigation of ships, while sofas covered with Utrecht velvet, buffets of richly carved walnut wood, carpets of surpassing softness, and *portières* of rich crimson silk to all the doorways, give an elegance to the whole, combined with a display of taste and beauty far surpassing, and an extravagance almost equalling, the gigantic toy ships of ancient monarchs.[1] Nor are the dining-rooms and family cabins much inferior in style, while the bed-rooms, in space, fittings, and comfort are all that the most fastidious voyager could expect, if not all they would desire.

[1] The decorations of this saloon, which were exceedingly beautiful, were executed by Messrs. Crace, of Wigmore Street, London.

Intended to carry twenty large boats and two steamers.

The *Great Eastern* was planned to carry twenty large boats on her deck or hanging from the davits. Some of these boats are patents on very ingenious principles. In addition, it was intended she should carry, suspended abaft her paddle-boxes, two small steamers, each 100 feet long and of between 60 and 70 tons burden. These were to be raised or lowered by small auxiliary engines and kept in all respects completely equipped for sea, but to be principally used for embarking or landing the passengers with their luggage.

Compasses.

The compasses were placed at a height of 24 feet from the deck on a staging, in order to remove them from the disturbing influences inherent in the vast masses of iron below; and it was proposed that strong shadows of the needle should be cast down a tube so that the steersman might by watching the shadow of the points at once follow the movements of the compasses above.

Size of sails.

Besides the mizen-mast, which is of wood, there are five other masts of hollow wrought iron. Two of these carry large square sails, the others fore and aft sails, the fore-mast having a jib as well as trysail, there being neither bowsprit nor jibboom. The standing rigging consists of iron wire rope, and the lower mast shrouds of this material are 8½ inches in circumference. The running gear, manufactured chiefly from Manilla hemp, is beautifully made. Instead of the ordinary dead-eyes and lanyards, an ingenious contrivance has been devised for letting go the shrouds instantaneously on an emergency. When under full sail the *Great Eastern* will spread 6500 square yards of canvas.

The magnetic apparatus or floating compass in-

vented and patented by Mr. John Gray, of Liverpool, is to the navigator, perhaps not the least interesting instrument of the great ship. The binnacle consists of an isolated battery of magnets adjusted by vertical screws, which move them in proportion to the deviation of the compass arising from the influence of the iron used in the construction or equipment of the ship. The original error having been ascertained by careful observations (a duty invariably devolving on the makers of the instrument) and the compass thus adjusted and regulated, the process of readjustment, when necessary, is so simple that, by the officer of the ship merely placing her head in two positions—north and south, east and west—the compass in the northern hemisphere can be made perfect. If any alteration takes place in the ship's magnetism of an opposite character in the southern hemisphere, by reversing the position of the magnet and by adopting the same process, the instruments will be found as correct as in the northern. There are other applications all calculated with the utmost precision for navigating the ship, one of which is highly important, in that it corrects the dangerous influence arising from heeling. A vertical magnet is made moveable in the centre of the apparatus so as to obviate errors arising from this cause, —errors sometimes amounting, by the deflection of the needle, to 50 or even a greater number of degrees. As these disturbances produce considerable oscillating of the card when the vessel rolls, their repetition often causes a momentum that ultimately makes the card revolve with such velocity as to render it useless to the helmsman.

Magnetic apparatus of Mr. J. Gray.

The patent floating compass, constructed to prevent vibration from affecting the centres of action, consists of an inner bowl floating in an outer one, the object being to render the former insulated in its water bed, the exterior being solely influenced by the action of the ship. Through a very ingenious mechanical arrangement in the interior of the inner bowl the hardest gems and the finest centres may be applied without fear of oscillation of the card. The entire combination of these essential points insures steadiness of action, perfect indication, and great durability.

There is also a vertical double disk to register the ship's course and to show whether the man at the helm has attended strictly to his instructions with regard to the course to be steered. On each side of the binnacle there is a metal box containing soft iron for the adjustment of any small amount of deviation in the quadrants, which remains stationary with its contents throughout every change of latitude.

Apparatus for steering. Nor must I omit notice of the mode of directing the course of the ship. On one side of the platform between the casements of the paddle-wheels (the deck most in use by the commander and officers of all steam-ships), stands an ingenious apparatus, in which there is a compass, the duplicate of the one in the binnacle, and before it an officer stands when the ship is under weigh, who is under the immediate eye of the captain. This pedestal is covered with a brass circular slide, with an aperture sufficiently large to permit of one of the points on the card being seen through it. The captain or officer in charge of the ship, by turning a handle, exposes the point at which

he wishes the ship's head to be kept, and by means of connecting rods a coincident point is disclosed on the compass in the binnacle, which is watched by the steersman, who thus knows in a moment the course he has to steer, so that, without verbal orders (which are frequently indistinctly heard and sometimes misunderstood, even when the officer is close to the helm) the ship is directed on her course with more ease than an ordinary sized vessel.

Beyond the original plan contemplated of manufacturing gas on board to be laid on to all parts of the ship, it was further intended to carry the electric light so as to secure a perpetual artificial moonlight around the vessel.

Rudder and anchors.

The rudder[1] is constructed of two plate-iron cheeks framed together on a wrought-iron rudder-post, tapering from 14 inches diameter downwards,

[1] As I have been frequently asked when the "rudder" was invented, I may here state that I really do not know, and I should be disposed to question the accuracy of any writer who fixed any epoch or any age for its invention. Before me I see, at this moment, a swan in pursuit of other swans which have evidently been poaching upon its manor on that portion of the River Thames where, on its banks, I now revise the proof sheets of this volume. It is in full chase, with its wings so arranged as best to gain advantage from the breeze; its feet are paddling it onward with great vigour, but to turn the corner opposite to where I sit, I see that the swan sweeps itself round by the operation of one of its feet, which has been brought close to the surface, and is performing exactly the same part, only in a more rapid and perfect manner, which the rudder, attached to a boat, performs, when sweeping round the same bend of the river. Perfect rudders may, therefore, be said to have existed from the creation, for nothing could be more complete in the shape of a rudder, than this action of the swan's foot in the water. A similar action may be seen in the fins and tails of fish.

Turning to mechanical contrivances which had this object in view, it will be found that, during the earliest historic ages, the paddle of the canoe was used, not merely to propel, as in the case of the gondola of the middle ages as well as in the gondola of to-day, but also to guide,

the frame being 9 feet wide from back to belly. The space between the 2 plate-iron cheeks within the rudder-frame is filled with solid blocks of wood, bound together and bolted through the plates, combining great strength with lightness.

There are ten anchors on board which, with their stocks, weigh 55 tons, and 800 fathoms of chain cable weighing 98 tons, the capstan and warps weighing 100 tons, so that there are 253 tons weight of appliances on board devoted exclusively to the

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and was, in itself, one of the most powerful mechanical rudders which have yet been produced. The oar over the quarter followed, and if my readers will refer to the sculptured illustration of a vessel on the leaning Tower of Pisa (see *ante*, vol. i. p. 521) erected A.D. 1178, they will find, that that was the only description of a rudder represented at that comparatively recent period. At a later period, by referring to the contracts still extant which Louis IX., King of France, entered into, A.D. 1268, with the Venetians and Genoese for the construction of various ships (*ante*, vol. i. p. 510), "two rudders" for each vessel (*one on each side*) "nine palms long" are required to be provided, showing that this mode of steering, which is no advance upon what may be found on the ancient sculptures of Egypt, was, then, the only one known, or at least in use, among the most celebrated navigators of the middle ages; and from their dimensions, the vessels which Louis IX. ordered to be built were large ships, *not boats*, which the one represented on the Tower of Pisa may have been.

In the drawings of some vessels of a subsequent period, a hole is shown in the stern above the stern post, through which an oar, sweep or "rudder" was passed for guiding the course of the vessel, its lower extremity being probably worked by tackles from each quarter; from this appliance the *hanging* rudder now in use no doubt originated, being improved on by slow degrees, and gradually assuming a more and more perpendicular position; thence, the transition to hanging it by a second ligature was easy and natural; thence, the gudgeons and pintals, by which the rudder now swings from the stern post; and, hence, the tiller and, subsequently, the wheel to move the tiller, the blade of the rudder itself being increased in size according to the force required to turn the vessel. Thus, the foot of aquatic birds first gave the idea of the paddle, and this, in time, was displaced by the oar, from which the rudder evidently sprung. The Dutch and German word for oar is now and always has been "Ruder."

purpose of anchoring or mooring the great ship. Through the centre of her stem there are two hawse-holes each 18 inches in diameter, so that the large cable runs straight out from the stem; and, besides these, there are additional hawse-holes on each side of the cutwater.

Such is or, rather, was the *Great Eastern* in all the leading features of her construction and equipment, and, however fallacious many of the calculations of the directors and designers may have proved, (and none were more so than those referring to the project as a commercial undertaking),[1] they and the

The ship itself a marvel though, commercially, a failure.

[1] In the summer of 1857, the late Robert Stephenson and I paid a visit to the ship. We were accompanied by Brunel. The hull was then drawing towards completion, and preparations for launching were about to be commenced. After thoroughly inspecting everything about the vessel, Brunel asked me what I thought of her. "Well," I replied, she is the strongest and best built ship I ever saw and she is really a marvellous piece of mechanism. "Oh," he said, rather testily and abruptly, "I did not want your opinion about her build. I should think I know rather more about how an iron ship should be put together than you do. *How will she pay?*"

"Ah," I replied, "that is quite a different matter;" and, seeing that I did not care to answer his question, he repeated it, adding, "If she belonged to you in what trade would you place her?" "Turn her into a show," I said, with a laugh, "something attractive to the masses; for, if you insist on having my opinion about her commercial capabilities, it is only in that direction where you can look for profit. She will never pay as a ship. Send her to Brighton, dig out a hole in the beach and bed her stern in it, and if well set she would make a substantial *pier* and her deck a splendid promenade; her hold would make magnificient salt-water baths and her 'tween decks a grand hotel, with restaurant, smoking and dancing saloons, and I know not what all. She would be a marvellous attraction for the cockneys, who would flock to her in thousands." And, as I saw he was far from pleased with my answer—no wonder—though given half in joke and half in earnest, I added, "As you would insist on having my opinion, I have given it to you candidly, for I really do not know any other trade, at present, in which she will be likely to pay so well." Stephenson laughed, but Brunel never forgave me.

constructors have produced a ship which is not merely a marvel in size, but, in beauty of symmetry, strength of hull, completeness of machinery, organization, and arrangement of details, equals, if she does not surpass, any vessel that has yet been constructed for ocean navigation.

It is to be regretted that the plans for launching the monster were not (for the credit of science and the great mechanical knowledge of the age) as perfect as the ship herself. Instead of constructing a dock, wherein she could have been built with less labour than upon piles, and which would have been valuable as a graving-dock when she was floated from it, they built her in a yard, and, contrary to the established custom, built her broadside to the element into which she had ultimately to be launched.

Preparations for, and details of, the launching of the *Great Eastern*.

The apparatus for launching the ship consisted of two inclined planes, each about 200 feet long by 80 feet broad, and nearly 140 feet apart, falling at an inclination of one in fourteen, to low-water mark. On these ways two cradles, each 80 feet square, were destined to slide, the object being that the great ship should be moved sideways into the river on two massive platforms, underlaid with transverse bars of hard iron, and corresponding in length to the width of the launching ways upon which they rested.

The cradles were provided with two enormous chains, with crab blocks and tackle, the standing part fastened to the further bank of the river and the ends carried through two portholes, and under the ship's bottom. Two small steam-engines in the yard worked the crabs and blocks attached to the chains

whereby the ship was, if necessary, to be dragged down the launching ways, which were prepared with an anti-attrition composition to facilitate the movement of the enormous mass. Besides these powerful tackles, there were two hydraulic presses, each of one thousand tons lifting power, placed behind the cradles, to which they could be applied to set the vessel in motion should the engines prove inadequate for that purpose.

But, in order to regulate the descent of the vessel, and check her progress, should it become too rapid, two immense friction drums or capstans were constructed, and fastened firmly by means of piles into the earth, so as to resist any possible strain that might be placed upon them. These drums, seven feet diameter in the barrel by twenty feet in length, were furnished with iron cables, each link of which weighed seventy pounds, attached by a double purchase to the cradle, and regulated by two gigantic break-levers worked by blocks and pulleys, a gang of men being at hand ready to apply instantaneously on receipt of signal this powerful check to the momentum of the vessel should it be found too great.

Such were the vast preparations made to launch the *Great Eastern*.

CHAPTER XIV.

Commencement of launch of the *Great Eastern*, November 3rd, 1857—Christened by Miss Hope—Comparative failure—Renewed efforts scarcely more successful—Hydraulic ram bursts—Floats of her own accord, January 31st, 1858—The whole scheme of this launch a thorough mistake—Difficulties of the company—Offer to Government wisely declined—Further proposal to employ her as a cable layer—Makes her first sea trip, September 9th, 1859—Accident off Hastings, and the opinion of the pilot—Reaches Holyhead; and details of her voyage—Makes her first voyage across the Atlantic, June 1860—Second voyage, May 1861—Third voyage to Quebec, July 1861—Fourth voyage, September 1861—Heavy gale off S.W. coast of Ireland, and compelled to return to Cork—General remarks on the sea-going qualities of different ships, and on the effect of wind in causing "rollers"—Real truth about "momentum"—Very large ships not so safe as smaller ones, as their damages are less easily repaired—Chief later use of the *Great Eastern* as a cable layer, but, not even here, remunerative—Concluding remarks.

Commencement of launch of the *Great Eastern*, November 3rd, 1857.

After various unavoidable delays rendered necessary by such an unexampled experiment, the day for the launching of the *Great Eastern* was fixed for the 3rd of November, 1857.

A vast concourse of people assembled on land and river to witness the launch. Crowds of naval and scientific men from all parts of the world were there, and, in spite of the inclement season of the year, numerous members of the aristocracy came to see this marvellous feat; nor indeed was royalty, itself, unrepresented. Probably no such multitude had on

any previous occasion congregated on the banks of the Thames. It was a magnificent sight, but one, also, the practised eye could not survey without apprehension of danger. The preparations for her launch were, it is true, made with the object of lowering the vessel slowly into the water by means of cradles erected on the launching ways, but if the huge mass had received the impetus which in all similar cases is given to vessels when the retaining and supporting shores are removed, the cables, though of unusual strength, would have proved altogether insufficient to restrain so ponderous a weight when once in motion; they must have snapped asunder like hempen cords, and, considering the number of small boats and steamers full of people at the time on the river, and the crowds on its banks, no one can contemplate without a shudder the loss of life which, under such circumstances, would have probably occurred.

By reference to the following illustration the reader will better understand the nature of the danger apprehended, and, also, see at a glance the position of the great ship as she lay on the cradles ready for launching.

The ceremony of christening the vessel was performed by Miss Hope (now Duchess of Newcastle), daughter of the Chairman of the Great Eastern

Christened by Miss Hope.

Steam Navigation Company. When the moment for launching arrived, the interest of the vast assembly of people who had gathered together to witness the operation became intense, increasing as the shores were one by one struck from under her and the last cable fastenings loosened. But the leviathan did not seem to move, and it was, only, when the stationary engines tightened the chains which passed from the vessel to the opposite shore, that any motion became perceptible. A tremendous cheer then burst from the excited multitude. Immediately afterwards, however, there was a pause: silent suspense again prevailed, with increased anxiety blended now with evil forebodings. A whisper passed along the dense crowd that the slide down the inclined plane of 3½ feet at the stem and 7 feet at the stern thus effected, was of an alarming character. It was one, too, which had not been anticipated; and, when it became known that the rapid revolution of the drum and fly-wheels caused by the sudden motion of the vessel had seriously injured several of the men employed upon these ponderous machines, there were grave apprehensions of further danger.

Comparative failure.

Some delay in the operations now necessarily occurred, but, at a quarter past three P.M., the time of high water, when the engines were again set to work, expectation was once more raised to the highest pitch. Every eye was now directed towards the cradles, but this time they did not stir an inch, and, as the chains tightened it became too apparent that if the vessel was not forced towards the water they must break. At length, subjected to a strain greater than ought to have been applied, the pon-

derous chain attached to the fore part of the vessel snapped asunder, and then all hopes of launching the leviathan were ended for that day. It would be superfluous to dwell on the many speculations as to the cause of this failure; certain it is that it was great and lamentable, and, as it was impossible to repair the injury the launching machinery had sustained, in time for further operations on the following day, no time was, then, fixed for resuming action.

However, on the 19th of November, these operations were again begun, the alleged object on this occasion being to move the great ship 40 feet lower down than the position she then occupied, so as to be ready for launching when the tide suited; but this effort equally proved abortive. The immediate cause of this second failure is accounted for by the abutments of the piles, against which the bases of the hydraulic rams rested, yielding under the enormous pressure exerted between them and the ship's cradle, in many cases giving way or breaking down altogether.

Renewed efforts scarcely more successful.

Most of the subsequent operations of the company were kept as far as possible secret, and the presence of the public, which had been courted to witness an anticipated triumph, was now as studiously avoided, under the prudential plea of avoiding accidents, involving loss of life, by the too rapid motion of the ship towards the river. But a fresh experiment, after prodigious efforts, and the snapping of one of the 3-inch chains, proving likewise unsuccessful, the report of it soon got mooted abroad, and the public, always fluctuating between extremes, now

began to entertain serious doubts whether the *Great Eastern* would ever get afloat.

A third attempt, on Saturday, November 28th, proved however more successful than the previous efforts. On this occasion the *Great Eastern* was gradually lowered down the launching ways some 25 feet in a slow but satisfactory manner; while, on the 1st December, when the tedious process of moving the gigantic structure was recommenced, she moved steadily, for a time, at the rate of half an inch a minute, but, suddenly, soon after slipped 5 inches forward and 9 inches aft, to the terror of every person engaged in the operation; and, when renewed efforts were made in the course of the afternoon, one of the ten-inch hydraulic rams burst, as might have been anticipated, under the tremendous pressure of 1300 pounds to the square inch of its cylinder: consequently, the work of launching was suspended for that day.

Hydraulic ram bursts.

Six weeks elapsed ere the operations were resumed, and, this time, with the most sanguine hope on the part of Mr. Brunel that the great ship would reach her destination by the spring tides of the 28th or 30th of January, 1858. On this occasion the plans could not be kept secret. Crowds of people were again in attendance, among whom were the Duchess d'Orleans, the Comte de Paris, and various other distinguished personages, as well as many men of science. The *Great Eastern* was, indeed, not merely the wonder of this age, but she created more sensation among men of scientific and maritime pursuits in all parts of the world than any vessel had ever done in any age. Nor was she an object of

much less interest at the time to the general public, while the difficulties of her launch and the appliances for this purpose were freely discussed, often in no friendly spirit, at the meetings of the learned institutions, as well as in the gay gatherings of Belgravia, and in the more humble homes and workshops of Mile End and Poplar. The subject was one of hardly less interest throughout Europe and the United States. But shrewd practical men, while envying the superabundant wealth of the shareholders, and admiring their boldness in investing in her as a commercial undertaking with so questionable a chance of profit, quietly sneered at the futile attempts to launch the leviathan. Though of unusual weight and size, they said, that had the ordinary process been adopted, she would have found her way to the water with as much ease and safety as a vessel of ordinary dimensions. There was no need, they remarked, to launch her broadway to the Thames, as, in their opinion, she might have been so built that when started from her ways she would shoot either up or down the river, as hundreds of vessels launched from the banks of much narrower streams had done before her.

However, on this occasion, the efforts at launching were so far attended with success, an average advance of 20 feet having been obtained in the course of the day, so that when the tide reached its height, the monster was $7\frac{1}{2}$ feet in the water; but the only distance accomplished on the following day, was one solitary slip of "$2\frac{1}{2}$ inches," and in this state she lay until Tuesday, the 31st January, when the great ship quietly floated of her own

Floats of her own accord, January 31st, 1858.

accord, the tide having risen sufficiently high to lift her from the cradles on which she had so long lain.

The whole scheme of this launch a thorough mistake.

The struggle of hydraulic power with the monster the company had created, and other appliances proved most expensive, the launch of this ship having cost no less than 120,000*l.* when 10,000*l.* or even 5000*l.*, it was said, might have sufficed;[1] nor, indeed, is it easy to understand how, with all the data before them, the tons weight to be lifted, the angle of inclination, and the well-known rate of friction, dynamic science could not have calculated with the utmost accuracy the amount of force requisite to move the *Great Eastern* on her launching ways. No adequate consideration, however, seems to have been given to these important matters, for additions were made, day by day, to the force applied, and these, too, experimentally, and not, as might have been expected, as the result of careful, previous calculations. No doubt the chief cause of this expensive failure is attributable to the fact that Mr. Brunel (it was well known at the time that Mr. Scott Russell strongly opposed Mr. Brunel's plan of launching) was permitted to try the almost insane experiment of launching the ship on *iron* instead of wooden ways, as has, hitherto, invariably been adopted in the launch of all other vessels.

The expenses attending the launch exhausted the funds of the *Great Eastern* Company; and brought it to the brink of dissolution. Nor was this the only trouble to which the *Great Eastern* was exposed.

[1] Mr. Brunel's estimate to the directors of the cost of the launch was 14,000*l.*

On the 5th of April, 1858, a sharp north-easterly squall, which swept the river with considerable violence, subjected her moorings to a strain so severe, that one of the chain cables on the port-bow parted about 20 feet below the hawse-hole, and for a time exposed the vessel to great danger; fortunately, however, this unfair weight snapped, also, the second stern-chain, and thus allowed the vessel's bows to swing in towards the Deptford shore, thereby saving the *Great Eastern* from more serious loss.

The difficulties, however, in which the company were involved had now become a matter of public notoriety; the more so, that the vessel remained for more than a year equally unfinished as on the day she launched herself, and was in fact nothing more than a vast iron hulk lying on the waters of the Thames. Ineffectual efforts were made to induce the public to come forward and subscribe the extra capital requisite to complete her, but the launch, and other circumstances, had increased the doubts long entertained by men of business with regard to the prospects of the ship, as a commercial undertaking; hence, the public could not be induced to re-invigorate the exchequer of the company with sufficient money to equip her for sea. The various suggestions made to persuade the shareholders of the company to come forward with additional capital, were of no avail and they all, alike, failed in raising the requisite funds. A negotiation was even opened with the Government with a view to the purchase of the vessel, the press, all at once, teeming with articles to the effect that, whether important or not as a mercantile adventure,

Difficulties of the Company.

Offer to Government wisely declined.

the great ship, as a vessel of war, would be "almost invaluable."[1] This discovery, it is true, had been previously overlooked, but it soon became the theme of general discussion.

The difficulties of the existing means of oceanic communication it was said, compelled Government to maintain larger forces at all points of the empire, and at the same time, than were actually requisite; consequently, it was argued that, with two or three such stupendous vessels as the *Great Eastern*, such a necessity would be obviated, and Government would really have increased strength, even though her present military establishments were greatly reduced. It was, further, urged that continental nations were well aware that the secret of England's weakness, as a military power, is not so much from the smallness as from the wide dispersion of her army. Once show that means exist for obviating this necessity, and that she is able, in a few days, to transport an army of 10,000 men to any part of Europe, and England's position, as a military empire, would be established. It was asserted that the political results, accruing from any Government having at its disposal such a class of ships, would be equally important; while the facility provided for the transportation of large numbers of soldiers across the seas would necessarily consolidate more closely the power of Great Britain with that of her distant possessions. The revolution a squadron of such vessels would effect in war would be as great as their results

[1] "What fleet (exclaims the writer of a leading article in one of the London daily papers) could stand in the way of such a mass, weighing some 30,000 tons, and driven through the water by 12,000 horse-power at the rate of 22 or 23 miles an hour?"

in commerce; moreover, for the first time, steam would achieve on the ocean what it had already achieved on land.

But the arguments employed by the negotiators, backed as these were by suggestions artfully thrown out by a portion of the public press, to the effect that foreign powers might become possessed of this invaluable ship to the prejudice, disadvantage, and dishonour of Great Britain, terminated in failure. Government decided against the proposal, and no alternative remained, but to wind up the affairs of the existing company and to endeavour to make some arrangement whereby fresh capital could be raised to complete the vessel.

The Atlantic cable, which was to form a telegraphic communication between Europe and the United States, was completed in the summer of 1858, and the vessels of war employed in laying it across the Atlantic having made an unsuccessful voyage on the first occasion, it was strongly urged upon Government[1] that the *Great Eastern* should be fitted up by the Admiralty for the purpose of laying it down, as the whole of the cable could be contained in this one vessel, thus diminishing the risks of failure necessarily inseparable from employing two ships, each starting in opposite directions from the middle of the Atlantic. But the prevailing opinion then was, though it changed a few years later, that the *Great Eastern* from her height out of the water was unadapted for such a service, and, further, that there were no public grounds on which the application of the necessary sum from

Further proposal to employ her as a cable-layer.

[1] See Mr. Griffiths' speech in the House of Commons, 9th July, 1858.

the Exchequer to assist the operations of a private company could be justified: therefore, Government distinctly refused to entertain the proposal.

Renewed endeavours were now made to re-organise the undertaking, and after much difficulty the affairs of the original company were wound up, the sum of 160,000*l*. having been accepted for the sale and transfer of the vessel to a new company, which came into possession of her in the beginning of the year 1859.

Makes her first sea-trip, September 9th, 1859.

Somewhere about 300,000*l*. having been subscribed for the new undertaking, which received the name of the Great Ship Company, the directors, after paying for the ship, had 140,000*l*. left to equip her for sea; but it was not until September 1859 that the *Great Eastern* was sufficiently complete to make her first trial trip. On Wednesday, the 9th of that month, she took her departure from the Thames under the most favourable circumstances, the weather being very fine with a light breeze of wind and blue sky overhead. Starting with four tugs, two on the bow and two at the quarter, to guide her through the narrow parts of the river, she, after some delay and a few slight mishaps, reached Purfleet, where she anchored for the night. At daylight, on the following morning she started for the Nore, where she arrived about noon, having obtained a speed of "13 knots" an hour, though only at "half-speed, her engines making not more than eight revolutions a minute.

From the Nore the *Great Eastern* proceeded successfully to Whitstable, where she anchored, getting under weigh, thence, at a quarter past nine on the following morning with a fresh breeze. After

passing Margate she encountered a stiff gale, where, as represented in the following woodcut, she appears "quite at ease," when "large ships were under double reefed topsails" and small vessels were obliged to "lie to."

But an unfortunate accident occurred to her, when off Hastings, through the explosion of one of her funnel-casings, causing the death of six men employed in the engineering department, injuring various others, and destroying nearly all the mirrors and other ornamental furniture in the grand saloon.

Accident off Hastings, and the opinion of the pilot.

68. "GREAT EASTERN," UNDER FULL SAIL AND STEAM, PASSING DOVER.

Though appalling enough at the time, no injury was done to the hull or machinery of the vessel sufficient to prevent her proceeding on her voyage to Weymouth, which she reached without any further misfortune on the afternoon of Friday, within the time anticipated for her arrival.

On her arrival, the pilot who had been in charge of the *Great Eastern* from Deptford to Portland (Weymouth Bay), made an official report of her performances to the company,[1] confirming, in some

[1] Extract from the pilot's report:

"On arriving at Sea Reach I found the vessel so completely under

measure, the glowing accounts in many of the public journals and realising the sanguine expectations of the directors, though their hopes of profit had been somewhat damped by the accident which, apart from the loss of life, entailed an outlay of 5000*l*. The necessary repairs having been completed, the *Great Eastern* proceeded from Portland to Holyhead, but without passengers as originally contemplated. Starting at noon of the 8th of October, she made the run to Holyhead in forty hours at an "average speed of close upon 13 knots or more than 15 statute miles in the hour," having on some occasions attained a speed of 15 knots an hour, the engineers and other experienced men on board feeling "thoroughly convinced that, when in the condition which the company has a right to expect, she will make easily 18 knots or 21 miles an hour."

Reaches Holyhead: and details of her voyage.

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command with the use of her own paddle-wheels and steam-engines, that I decided on casting off the steam-tugs altogether, and proceeding afterwards without any assistance. On reaching the North Foreland, we experienced a stiff double-reefed topsail breeze, during which other vessels were pitching and tossing a good deal, and, on passing the Downs, the wind increased to a close-reefed breeze, and many large vessels were lying with two anchors down. Throughout, the vessel steered with the greatest ease, and, literally, without any perceptible motion, and for some time I have no hesitation in stating that, computing our distance by points on land, which admit of no mistake as to distance, we were making fully 14 knots an hour with both paddle-wheels and screw-engines working fully one-third under their pressure. The misadventure, which occurred off Hastings, in no way interfered with the working or progress of the vessel, and, with the single engineering accident in question, we made the voyage from Deptford to Portland without any check or interference of any kind. The vessel is, in every respect, an excellent sea-boat, and I may state without any hesitation that, with sufficient sea-room, she is even more easily handled and under command than an ordinary ship, either sailing-vessel or steam."

The paddle-engines, during one portion of the passage where a careful record was kept, appear to have made from $8\frac{3}{4}$ to $9\frac{3}{4}$ revolutions per minute, and the screw from 32 to $33\frac{1}{2}$ revolutions in the same time, the pressure being 20 pounds per square inch in both cases with the throttle-valves half closed and both engines working on the second grade of expansion, giving an average speed of 12 knots an hour, but with an outlay of "10 tons of coal per hour." On another occasion when the sails were set, and the weather more favourable, she is said to have attained a speed of 15 knots, with the screw making from 38 to 40, and the paddles from $10\frac{1}{2}$ to 11 revolutions per minute, and, at this rate of speed, the screw boilers consumed on the average at the rate of 170 tons per day, and the paddle-engines on the average 110 tons, giving a consumption of 280 tons of coal each day under favourable circumstances. During the highest rate of speed the engines made 11 revolutions for the paddles per minute and 43 for the screw. A special trial gave the speed of the ship under paddle-wheels alone $7\frac{1}{4}$, and under the screw alone 9 knots an hour.

Having made the trial trip to Holyhead to the satisfaction of her directors, the *Great Eastern* left that harbour shortly after noon on the 2nd of November for Southampton, but did not leave that port on her first voyage across the Atlantic until the morning of the 17th of June, 1860, reaching New York on the 28th of that month. The greatest speed attained during the passage was $14\frac{1}{2}$ knots an hour, and the greatest distance run in any one day

Makes her first voyage across the Atlantic, June 1860.

333 knots.[1] Only thirty-six passengers were found bold enough to accompany her on this voyage, besides two of the directors. But the Americans gave her a warm and hearty reception on her arrival at New York; hundreds of small vessels crowded with people having gone out to meet her and bid her welcome, the scene in the North River, where she moored, being described[2] as a "perfect ovation."

In the report which the directors issued to the shareholders[3] shortly after the *Great Eastern* returned to Milford Haven (where she was placed with great skill on a gridiron and had her bottom cleaned and painted) they state that 14,000*l.* had been remitted from the agents at New York, and, though they had not then furnished their accounts, the directors expressed a hope that the receipts would cover the expenses of the trial trip to America without trenching on the capital; they, however, stated that heavy outstanding claims remained unsettled, and that they would require, to meet these demands and put the ship into good working order, an additional capital of from 30,000*l.* to 40,000*l.*

[1] Her daily performances were as follows:

17th June	285 knots
18th „	296 „
19th „	296 „
20th „	276 „
21st „	304 „
22nd „	280 „
23rd „	302 „
24th „	299 „
25th „	325 „
26th „	333 „
27th „	254 „

[2] Letter from passenger in the *Great Eastern*.

[3] 14th October, 1860.

The requisite sum having been provided, the *Great Eastern* left Milford Haven on her second passage for New York on the 1st of May, 1861, with 100 passengers. On this occasion she consumed from 159 to 295 tons of coals per day; the entire distance (3093 miles) being accomplished in ten days, though the wind, by her log, appears to have been ahead during a considerable portion of the voyage. In one day, she accomplished a distance of 348 nautical miles, her *greatest* speed being 14½ knots an hour, or one half knot per hour less than the *average* speed anticipated on a voyage to India.[1]

Second voyage, May 1861.

On the return of the *Great Eastern* to England in the following month of June, the apprehension of war with the United States occasioned by the *Trent* affair induced the British Government to engage her, with other steamships, to transport troops and munitions of war to Canada. But those embarked (or rather, for prudential reasons, allowed to embark) fell far short of the number her designers had contemplated; they had estimated 10,000, but the Government wisely limited the number to 2079 men, 46 officers, 159 women, and 244 children, besides

Third voyage to Quebec, July 1861.

[1] In the various newspapers and reports I have searched for information about this ship, and other inquiries, I have never had any reason assigned for the *Great Eastern* not having been placed, when ready for sea, on the India line, from which so much was expected of her, and for which she was specially built; or why her new directors sent her, on hap-hazard and expensive cruises, down channel and across the Atlantic, when every trip showed a ruinous loss. But I suppose the true reason is to be found in the fact, that they could not obtain for either India or Australia sufficient goods and passengers to justify the heavy outlay necessary for such long voyages (the cost of outfit may in itself have been an obstacle), and that, in truth, there was no branch of maritime commerce wherein she could then be profitably employed.

40 cabin passengers who were civilians. Having landed her troops at Quebec, she left that place on her return to England at four o'clock on the morning of the 6th of August, and, though detained twelve hours in crossing the bars in the River St. Lawrence, she arrived at her moorings in the Mersey on Thursday at 8.30 P.M. of the 15th of that month.

Fourth voyage, September 1861.

Early in the course of the following month, the *Great Eastern* sailed from the Mersey on her fourth Transatlantic voyage with 400 passengers of different classes for New York. On this occasion she encountered, on the 12th and 13th of September, a heavy gale of wind when about 280 miles off Cape Clear, and sustained so much damage that she was obliged to put back and seek shelter in Cork Harbour. Various accounts of this disaster appeared, at the time, in the daily journals. Her paddles, it would appear, were seriously injured, and her rudder "rendered useless." Nor do the writers of these accounts speak very highly of the anticipated superior sea-going qualities of the great ship, or of her freedom from that violent motion in a gale, to which ordinary vessels are subjected. Indeed, one of her passengers on this occasion, in a letter he addressed to the *Times*, gives the most melancholy account of her, but this description of the disaster and the imminent danger to which her passengers were exposed, is probably exaggerated.[1] Landsmen in a gale, especially when

Heavy gale off the S.W. coast of Ireland, compelled to return to Cork.

[1] "*Thursday.*—This morning we have a fresh gale, with a good sea. Noon: A heavy gale; wind, from north to west; sea, tremendous. We roll very heavily, and ship many seas. I now begin to understand the true meaning of a gale in the Atlantic. The captain looks anxious, but the passengers have faith in the 'big ship.' The 'rolling' is

anything goes wrong, generally, take the most gloomy view of matters; they picture to themselves dangers which have no reality, and, when they see the seamen hurrying to and fro to rectify, as far as possible, any damage the ship may have sustained about her spars, rigging, or bulwarks, they too frequently give themselves up for lost.

So long as the hull of a ship keeps sound the action of the ocean, however disturbed, does not,

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fearful, and quite upsets all persons' notions of the steadiness of the *Great Eastern*. Two o'clock: Things look worse. The captain tries to put our head to the wind. The port paddle gives way with a great crash in the attempt. The jib is set, I presume to aid in steering, but it is blown to ribands in a few moments. The rolling increases; the deck presents an angle of 45 degrees, and none but experienced seamen can walk about. Attention is suddenly drawn to the boats; they are suspended on either side, but mostly on fixed davits. The heavy rolling brings the boats in violent contact with the waves. The tackling of the long boat becomes deranged; a man and a boy enter it to remedy the evil, but the wind strikes the boat, and gives the occupants forcible ejectment, happily upon the deck, and in a moment it is floating far away from us. Four other boats share a similar fate in rapid succession. Continued efforts are made to bring the ship to the wind. I watch the men at the wheel—there is almost an army of them. 5.45.—Our position is indeed critical. A tremendous sea has just struck our stern. It has broken her rudder head. Still, we are not quite at the mercy of the waves; we have our screw, and we have our starboard paddle. The wind is now getting to the south-west.

"*Friday*, 6 A.M.—We are drifting before the wind at the rate of 3 or 4 knots an hour. We have never been more than 300 miles from land. We are drifting eastward now; but, even if the wind does not change, it will be many days before we can reach land in this manner. The pumps are all going. I do not like the sound, but am assured they have complete mastery over the water. The water has got in through the ports and by way of the deck.

"There is scarcely a cabin in the ship to which the water has not found its way. Many require a change of clothes, and the hatchways of the baggage stores are opened. The scene that presents itself defies all description. The water has got in, and in sufficient force to float even many of the larger articles. The rocking of the ship has set the whole mass in motion."

materially, affect her safety, but, in this action, the landsman, too frequently, sees just that kind of danger which the sailor is said to have dreaded during a gale on land, from falling slates and broken chimney-pots, congratulating himself that he was at sea and not on shore in the midst of the storm.

General remarks on the sea-going qualities of different ships.

On the other hand, the anticipated ease and safety of the *Great Eastern* during a gale was about as much exaggerated, as the discomforts and danger the narrator of the gale has described. One enthusiastic writer, among numerous others equally sanguine, in his description of what might be expected from the great ship in a storm, remarks "she will set circular sailing at defiance," as if circular sailing has anything whatever to do with the sea-going qualities of a vessel. He then exclaims: "The line which in a tornado is said to make a steady but resistless run of 20 miles will be counteracted by the 'wave line,' which Mr. Scott Russell has adopted as the principle on which she has been built. Storms and tempests will be looked upon as merely sublime phenomena, in nowise menacing peril as things scarcely affecting the ship, but to be gazed upon out of snug cabin windows as interesting episodes of the voyage."

So much for the two extremes, but from these glowing anticipations on the one hand, and the exaggerated account of the actual event on the other, some lessons may be learned. The wave line (whatever may be its advantage, if any, over the lines usually adopted by shipbuilders) can produce no sensible difference in the violent motions of a ship at sea, even if it tends to promote greater speed.

Waves are of greater length and height, according to the force of the gale and its extent of sweep over the ocean.[1] In channels, where broken by projecting points of land or promontories, they are short and disturbed. When crossing the whole breadth of the Atlantic during a westerly gale, they are long, and, as they roll between the headlands forming the Bay of Biscay, they are also disturbed, rendering a voyage across that part of the ocean a proverbially unpleasant and, with deeply laden and badly found ships, a somewhat dangerous one. To insist, therefore, as some writers appear to have done, that the lines of a ship should be in conformity with the length and action of the waves, or that, by a careful study of the law of fluids, they can be so drawn as to render, under all the varied circumstances of a long voyage, one ship more easy or even more swift than another, is, I fear, attributing to science more than it can reasonably claim; for though, by its general application to the models of ships, great improvements have of late years been made, I can hardly suppose that *lines*, based on the action of fluids, which must be more or less disturbed by the weight and velocity of a vessel passing through them, and by the action of the winds on their surface, do really possess any superior advantages so far as regards greater ease, speed or safety.[2]

and on the effect of wind in causing "rollers."

[1] "From a paper of great interest it would seem that, approximatively, the cube of the height of the waves is proportional to the square of the velocity of the wind. Most of the conclusions drawn in this paper are from observations made during the voyages of the *Bonite* and *Astrolabe*." ("Naval Science," October 1874, Part II., p. 159.)

[2] See paper on "The Difficulties of Speed Calculations," by Mr. Denny, read at the Institution of Engineers and Shipbuilders in Scotland, 23rd March, 1875, pp. 2, 3, and 4.

Nor had the idea, which prevailed at the time, that a ship of the vast dimensions of the *Great Eastern* would bid defiance to the danger of the ocean, much more foundation in fact. No doubt a vessel of 1000 tons is a much safer mode of conveyance across the Atlantic than one of 100 tons, and a vessel of 2000 tons may be still more so, but not to either the same degree or extent. Moreover, a ship of double that size, or say 4000 tons, is no safer, though she may be more comfortable, for various self-evident reasons, such as being less liable to receive on deck the crest of the waves, or by affording more space and better ventilation in her cabins; but anything beyond that size will, assuredly, not realize much greater speed, though she may afford greater comfort.

A vessel of 100 tons is lifted by every large wave, and, consequently, the distance she has to traverse is increased. As the size is enlarged this particular description of motion diminishes, in proportion to the length of the vessel. But there is a limit to this advantage, as there is to most other things, and a vessel of 5000 tons and 400 feet long, will be, similarly, borne on the crest of two or more of the largest waves as a vessel 700 feet in length, and, therefore, would lose nothing in speed from the ascending and descending motions: this fact has, indeed, been satisfactorily proved, as the ships of the Ismay, Cunard, Inman, Allan, and other lines of steamers employed in Transatlantic voyages have made more rapid passages than ever the *Great Eastern* did.[1] Speed, beyond a certain size, is determined by the model, and the power of pro-

[1] See Appendices Nos. 10 and 17, pp. 606 and 617.

pulsion, due regard being had to the weight to be propelled and the resistance offered by the depth and extent of immersion. The momentum, about which a great deal was said and from which so much was expected in the case of the *Great Eastern*, though of some importance, when vessels of 100 tons are compared with those of 1000, is of much less consequence in the case of vessels of unusual weight and dimensions. It is at best only transitory, while, to drive a vessel of 20,000 tons through the water at the rate of 15 miles an hour, somewhere about four times greater power would be necessary than to secure the same speed in a vessel similarly constructed, of 5000 tons, although less power in proportion to tonnage would suffice in smaller vessels.

Real truth about "momentum."

But, with regard to the first and by far the most important consideration, the safety of a vessel at sea, I am disposed to think, though contrary to the generally accepted view, that ships of vast dimensions are less safe, in exceptional circumstances, than those of ordinary size. Take for instance the case of the accident to the *Great Eastern*, to which I have just referred, in which she lost her rudder, or when, at all events, it was so seriously injured as to be rendered inefficient. I need say nothing of the difficulty, or it might be of the impossibility, of providing a temporary mode of guiding a vessel of such huge dimensions. The loss of the rudder of any vessel in a gale of wind is no doubt a serious matter and one which must ever cause peril, but that peril increases with the size of the ship, for, when thus rendered helpless, the greater the bulk, the greater is the resistance offered to the action of the waves as

Very large ships not so safe as smaller ones, as their damages are less easily repaired.

they strike her sides. This is exemplified, though to a far greater degree, by the fact that a strong ship, on which the beating of the waves in the open sea would make little or no impression, would be dashed to pieces by the same waves if she was stranded on a lee shore. A large ship without rudder and, consequently, helpless in the hollow or trough of the sea would offer resistance to the stroke of the wave in proportion to her weight, and the wave would, consequently, strike with the greatest force on the body of the greatest weight. This, in some measure, and not without reason, accounts for the alarm created in the mind of the passenger on board of the *Great Eastern* during the gale he so graphically describes.

Chief later use of *Great Eastern* as a cable layer,

From the time of this disaster, the movements of the *Great Eastern* are not of much historical interest, so far as regards merchant shipping. It is true, that she proved of great value and importance in laying the Atlantic telegraph cable during the summer of 1865, and, in the very skilful feat of picking up from the depths of the ocean the broken ends, and in laying another Atlantic cable during the summer of 1866, when no other ship of sufficient dimensions could then have been found to perform that difficult and hazardous undertaking.[1] She has also proved very useful since, in other similar operations, in India and elsewhere; but, for ordinary commercial opera-

[1] 1000*l*. per month was paid for the use of the ship alone. When the agreement expired in 1867, she was chartered by a French Company to carry passengers between New York and Brest for the Paris exhibition. Her cabins were then altered and redecorated, and new boilers fitted to the screw engines. But the French Company was unsuccessful, and the *Great Eastern* only made one voyage in its service.

tions as various persons predicted,[1] when she was first projected and long before she was sent to sea, she

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[1] Towards the close of the year 1857, when the prospects of the *Great Eastern* were exciting much public attention, the author ventured to offer to his constituents at Tynemouth, nearly all of whom were interested in ships, the following remarks (reported in the newspapers of the period) with regard to her:

"Very shortly there will be launched a ship of vast and hitherto unparalleled dimensions: I allude to the *Great Eastern*. If that ship answers, I do not know where we shall be with our small vessels. As this is a subject, upon which opinions have been greatly at variance, perhaps you would like to hear mine. It must be a matter of deep interest to all present, because you are all directly or indirectly interested in the shipping trade, to know whether such a ship as the *Great Eastern* is, or is not, likely to answer in a commercial point of view, and I venture on this topic because I have heard strong opinions expressed to the effect that, commercially, she will be a great triumph. For my part, I believe her to be a great triumph of mechanical skill, I believe that no finer or stronger vessel has ever been put together: so far as regards her formation, I think she is a very splendid model: but, with reference to the speed she is expected to attain, I doubt very much whether she will ever realise the anticipation of her builder, though I think that we, as a nation, ought to be proud of having men who can produce so marvellous a piece of mechanism. But we must look, also, to the commercial element, because in this, I, and most of you are deeply interested. If such a ship as the *Great Eastern* be found to answer commercially, most of our property will go to the wall, for, in a short time, our small vessels will be of very little use to us. The course of commerce is this: If a Manchester merchant has 1000 bales of a particular description of goods to send to Calcutta, he does not send the whole of them in one bottom, because he might thus overstock the market. On the contrary, he sends them in from four to six different vessels, and he does this for two reasons: first, that by so doing he feeds the market; and, secondly, that he gets, thereby, quicker returns. The principle of commerce is to send out supplies in relays. Then again, we find that passengers do not go out in masses, but, at such intervals, as suit them best And, in times of war, statesmen find it the wisest plan to send out not 1000, much less 10,000 men in one bottom, but from 400 to 600, at the utmost, in one ship. And this must appear to be sound policy, when we picture to ourselves what might be the result of sending out a whole army in the *Great Eastern*. I do not take into consideration the contingency of the ship going to the bottom. I shall not ask you to imagine so fearful a calamity, but, supposing anything happened to her machinery and occasioned a

has been a ruinous, though not a lamentable failure.[1] Even the work of laying cables was not remunerative, for, by a report of the directors issued in March 1869, it appears that the great ship had been arrested for a debt of 35,000*l.*, that the current expenses had, considerably, exceeded the receipts, and that there were other claims which had to be met, before she could again proceed to sea. These difficulties were, however, overcome. The debt of 35,000*l.* was settled for the comparatively moderate sum of "4000*l.*!" and the other demands, though not nearly so extortionate, were amicably adjusted. In 1868 the *Great Eastern* was again chartered by the Telegraphic Construction and Maintenance Company, for the purpose of laying a telegraph cable between Brest and Ducksburgh near Boston; and for the same company she laid a telegraph cable between Aden and Bombay in the spring of 1870.[2] In 1873 and 1874 she laid other two cables between

but not, even here, remunerative.

serious stoppage, when expedition was necessary to the attainment of a certain object, the effect would be that the whole army would be detained. No Government would dare to send so large a force in one vessel. Therefore, looking at the question, politically as well as from a commercial point of view, I am of opinion that we have nothing to fear from the competition of leviathans such as the *Great Eastern*."

[1] If any further proof was required that the *Great Eastern* proved a failure in the two points, speed and comfort at sea, on which her protectors mainly built their hopes, it will be found in a small and amusing book by M. Jules Verne, translated from the French, and published by Messrs. Sampson Low and Co. (1875), entitled "The Floating City." M. Verne, who made a voyage in this ship in 1867 from Liverpool to New York, records, from the official returns, her speed as not exceeding 250 nautical miles each day on the average, and he describes her movements during strong winds as "rolling frightfully, her bare masts describing immense circles in the air."

[2] It has been stated that the loss upon the *Great Eastern* up to this period amounted to close upon 1,000,000*l.* sterling!

Valentia and Heart's Content in Newfoundland; and on the 25th of July, 1875, she completed her charter (20,000*l.* per annum), and was handed over to her owners. Since then she has been placed upon a gridiron to have her bottom cleaned, and I daresay her owners are now at a loss to know how she can be profitably employed.

But it will hardly be gainsaid, that the building, launching, and navigating such a ship are events in the history of merchant shipping, sufficiently important to justify the extent of space devoted to her in these pages; and, should my imperfect record survive for the next hundred or fifty years, there may be found in these pages a collection of facts relating to a ship, more marvellous than that of Hiero, King of Syracuse, or of the Pente-conter of Ptolemy Philopator. Perhaps, too, this record may contain more details of value, than the historians of those ships have handed down to posterity, for it may be that, a hundred or fifty years hence, the maritime commerce of the world may have grown to an extent sufficient to justify, with reasonable prospects of profit, another ship of the dimensions of the *Great Eastern.* I can only write of the past and the present, leaving the future to be dealt with by those who may follow me, and, perhaps, all that posterity will be able to say against the enterprising promoters of the *Great Eastern* may, hereafter, be condensed in the flattering eulogium, "their ideas in regard to dimensions were in advance of their age—they were only before their time." Though far from realizing the expectations once entertained with regard to speed and

Concluding remarks.

small consumption of fuel, her failure is, mainly, to be attributed to the fact that, at the time she was constructed, there were no lines of traffic on which a vessel of such huge capacity could procure, with despatch, the amount of freight or passage money necessary to insure a profit. But, from first to last, even when the failures of her launch had become too apparent, the people of England were proud of her, and this is not surprising, for no other country could have raised, by voluntary subscription, and without any aid from Government, the capital requisite to construct and equip this monster ship for sea.

That their pride should have found vent in numerous paragraphs in the public press is only what might have been expected, for, though shrewd men shook their heads, and cautious men declined to invest their capital in the ship, she was a marvellous piece of workmanship, even the Americans admitting, that England might well feel an honest pride in having produced such a triumph of mechanical skill, and welcoming her as they did to their shores, as a characteristic evidence of the genius, energy, and pluck of their fatherland.

Although I have not hesitated to expose the want of forethought, which rendered the *Great Eastern* a commercial failure, and the grave mistake in her launch, I cannot refrain from admiring the extension of the spirit of national pride to private undertakings such as these. Much has been learned and much has still to be learned from her. Various mechanical contrivances, now in use, were first adopted in this great ship. In herself she indicates the most

astounding progress. Indeed, when I consider that only forty years had elapsed since the small engines of the *Comet* which, though they puffed and strained, and made noise enough to frighten the people who watched the little vessel in her progress down the Clyde, were the finest of the period, and compare them with the vast engines of the *Great Eastern*, working in their combined action without the slightest jerk, and almost noiselessly, my mind is lost in wonder at the prodigious advance made, within my own time, in this mighty civilizing instrument.

CHAPTER XV.

River and coast trade of Great Britain—The *Iona*, paddle steamer—First screw collier *Q. E. D.*—The *King Coal* collier—Her dimensions and crew, *note*—Improvement in care of seamen—Leith and London traders—Dublin and Holyhead Mail-Packets—Their great speed and regularity—Dimensions, power, capacity, and cost—Dover and Calais Mail-Packets—The *Victoria*—Her speed—Proposed tunnel and other modes of crossing the Straits of Dover—Mr. Fowler's plan—The *Castalia*—The *Bessemer*—Her swinging saloon—The cigar-ship built at Baltimore, 1858—Similar ship built on the Thames, 1864—Perkins's economical steam-engine and proposed fast boat—The Engine of the *Comet*—Modifications in the construction of Marine Engines—Ratio of speed to power—The Compound Engine more economical than the simple—Great skill required for building perfect ships, and, especial importance to England of having the best ships—But her ships not yet perfect, though great progress has been made during the last half century.

River and coast trade of Great Britain.

ALTHOUGH Great Britain supplies from its rivers and coasts three-fourths of the ocean-going steamers of the world, its own coasting and inland navigation affords but a very limited field for the employment of vessels of any kind compared with the shores and rivers of America, India, and China.

Before the introduction of steamers, a few row-boats, sailing wherries, and barges were sufficient to conduct the whole of the river traffic. This new expedient, however, though soon met in another form by the competition of railways, has vastly developed even this comparatively limited trade. Steam-boats now,

whether on business or pleasure, are to be found in great numbers on every navigable stream, and are still on the increase; indeed, the improved facilities for intercourse on land, so far from retarding that increase, gives fresh life to the swarms of passenger-boats, yachts, steam-launches and steam-barges, which ply wherever they can find the means of flotation, and, especially, on the Thames and Clyde.

Offering, as it does, greater inducements than any other river in the United Kingdom, there are now to be found on the Clyde many elegant and commodious steam-boats. Although generally inferior in size, equipment, and speed to those of the Hudson or Long Island Sound, one of them, the *Iona*, a paddle-wheel boat, employed in the passenger traffic between Glasgow and the Western Highlands, is almost unrivalled.[1] This beautiful vessel affords deck and cabin accommodation for no less than 1200 passengers, and her long range of saloon houses, with plate-glass windows extending right fore and aft, gives her a graceful and imposing appearance. Fleets of similar vessels, though of inferior dimensions, now ply between Glasgow and the numerous watering places which line the shores of the estuary of the Clyde, presenting a striking contrast to the times of Henry Bell's *Comet*.

The *Iona* paddle steamer.

Equally marked has been the improvement in the

[1] The dimensions of the *Iona* are 250 feet in length and 25 feet breadth of beam. She is propelled by a pair of oscillating engines, with a combined nominal power of 180 horses. Her draught of water, when fully laden, does not exceed 6 feet, and her speed under favourable circumstances is from 20 to 21 statute miles per hour. She is the fastest vessel in Great Britain, or perhaps in the world, one or two of the steamers of the United States excepted.

vessels now employed in the coal and coasting trades of Great Britain. From the sailing-vessels of the north-east coast, of which an illustration has been furnished,[1] we advanced to the screw, and, in 1844, built of iron the first screw-collier, the *Q. E. D.*, for the conveyance of coal from Newcastle to London. She was heavily barque-rigged, and, in style and form, somewhat resembled the fast Baltimore clippers, the intention of her owners being to depend chiefly for speed upon her sails, and to use her engine as an auxiliary power. Her mizen mast, a hollow tube of iron, was made to serve the purpose of a funnel, and the whole of her standing rigging consisted of *wire rope.* She had a double bottom, divided into separate chambers, so that any injury to the one would not affect the other, each being covered with a false floor and hermetically closed. Into these vacant spaces between the bottom and the floors, water could be admitted by means of cocks, for the purpose of ballast, and, at the same time, easily pumped out again by an engine when not required. The *Q. E. D.* therefore, in herself, contained many inventions then little known, the more important of which, as the wire rope and water ballast, are now in general use. But the auxiliary engine and full sailing rig did not answer in the coal trade better than it had done for distant voyages, the sails in this, as in all cases, having become auxiliary to the engine as a propelling power. Steamers of light rig and comparatively full power, now carry on the largest proportion of this trade, although there is still room for a considerable number

First screw collier, *Q. E. D.*

[1] Vol. ii. pp. 536–7. The *Q. E. D.* was 120 feet long, and 27 feet wide. She registered 272 tons.

of the old sailing-colliers. An illustration of one of the finest steam-colliers will be found on the following page, and I am enabled through the courtesy of her owners to furnish not merely a drawing, but the particulars of this vessel, which bears the appropriate name of *King Coal*.[1] The *King Coal* collier.

We see, here, another instance of the vast progress of the last forty years. The ordinary collier of that period, of 230 tons register, or with a capacity of from 16 to 17 keels of coals, required[2] a crew of ten men, and from a month to five weeks for the round

[1] The *King Coal*, which was contracted for in the latter end of the year 1870, cost complete for sea 15,000*l*. She carries 900 tons coal cargo, with bunker space for 100 tons more, and has extra water-ballast for making a passage when she has no cargo on board; against strong winds her speed is 8½ knots an hour when loaded, and from 9½ to 10 knots when light in fine weather; her power, 90 horse nominal. She has an excellent saloon cabin on deck for the captain, with four berths and accommodation for the chief mate and steward at the entrance; her crew consists of 17 persons all told. The master and crew find themselves in provisions; their respective duties and pay are as follows:— Her dimensions and crew.

Master . .	£17 0 0	per month, with 2*s*. 6*d*. per day subsistence money.	
1st Mate . .	7 10 0	" " 2 0 "	"
2nd " . .	6 10 0	" " 1 6 "	"
Chief Engineer	12 7 6	" " 2 6 "	"
2nd "	8 15 0	" " 2 0 "	"
Steward . .	5 10 0	" " 1 6 "	"
5 Able Seamen	6 15 0	" in full each man.	
4 Stokers . .	6 15 0	" " "	
1 Boy . . .	3 0 0	" " "	
1 Carpenter .	8 5 0	" " "	

The voyage from Newcastle to London and back usually occupies from six to eight days. Hoisting sails, lifting anchor, and other heavy work is done by steam winches. The crew are accommodated in a roomy and well ventilated forecastle level with the main deck, the seamen occupying one side of it, the stokers the other, with a bulkhead between them. The engineers have cabins on deck in the bridge-house, the wheel-house stands on the platform which spans the deck in midships, and is so arranged that, while the helmsman can see everything ahead, he is protected from the inclemency of the weather.

[2] See *ante*, vol. ii. p. 536.

"KING COAL."

voyage to London. In the course of the year she delivered, under the most favourable circumstances, 3500 tons of coals; but the screw-collier of to-day, requiring a complement of only seventeen men, including the engineers and stokers and a steward (a luxury wholly unknown to the collier skipper of byegone days), conveys, annually, on the same round, 50,000 tons; while the deck-houses for the protection of her men in wet and stormy weather are comforts the crew of a sailing-collier never would have dreamt of.

Nor are the seamen less cared for in other respects. The accommodation provided for the collier sailor of to-day is of an order very superior to that afforded him forty years ago. Thus he can make sure of a dry bed and a fire to cook his victuals during the stormiest weather, comforts too frequently unknown to his predecessors; if he may still have causes for complaint, they are incomparably few to those his fathers had before him, and if this service does not now produce the same class of hardy men, who helped to crown the ships of England with laurels of immortal fame in the days of Duncan and Nelson, this arises, in some measure, from the fact that the good living and comforts of modern times tend to render them less willing to endure, or perhaps less disposed for, the prompt and resolute action which, in most achievements, alike of war and peace, insures success.

Improvement in care of seamen.

But, even, if it be true that the seamen of to-day are too much pampered and nursed, they have, unquestionably, in their profession many hardships still to endure, with discomforts and even dangers, which might be avoided. The philanthropist, however, who advocates changes likely to weaken the Inspired

maxim that man was born to live by the sweat of his brow, forgets his calling and injures those whose cause he advocates.

Leith and London traders.

In every other branch of our coasting trade, the change has been quite as marked as in that of the coal trade, steamers, on all the important lines, having superseded sailing-vessels. A few of my readers may remember the celebrated Leith smacks which derived their name from trading between that port and the Thames, carrying on, before the invention of railroads, a great portion of the passenger and goods traffic between Edinburgh and London.[1] Although the line of maritime communication, thus opened in 1809, was conducted in these smacks with considerable success, they were, subsequently, in part, replaced by clipper schooners, vessels of great speed, which maintained their position for some years against the steamers of the General Steam Navigation Company; but the London and Edinburgh Shipping Company, to whom they belonged, were obliged, in 1853, to adopt the new mode of propulsion, so that all the most valuable portion of this trade is now conducted by steamers. Indeed, they

[1] These celebrated smacks were from 160 to 200 tons register. In the early part of this century (before the close of the great war) they sailed in company for protection. On one occasion they were attacked by a French privateer, heavily armed, to which they gave action, and, after a severe encounter, beat her off in gallant style; the senior captain, Nesbitt, acting as "Commodore" of the little fleet. Each of these smacks had accommodation for about twenty first-class passengers. The passage between Leith and London, a distance of 500 miles, usually occupied from three to five days, but has been made in fifty hours, although it was not, unfrequently, protracted from eight to twenty days. The first-class fare, including a table "groaning with food," but exclusive of wine, spirits, or beer, was only two guineas each person; a rate which must have left little profit on long passages.

now encircle the whole of the coasts of England, Scotland, and Ireland, and there is hardly a port in the kingdom which has not its steam-ship communication either with the respective capitals or elsewhere.

Although constructed chiefly for the conveyance of goods, most of these lines have excellent accommodation for passengers, especially those I have just specified. This is also the case with the steamers plying between London, Dundee, and Aberdeen, Glasgow and Liverpool, and with many of the lines connecting Ireland with England and Scotland. Among the most celebrated are the Dublin and Holyhead packets, whose work is confined exclusively to the conveyance of the mails and passengers. Before the introduction of steam-vessels, it was no unfrequent occurrence for the sailing-packets, then engaged in this service, to be three or more days in crossing the Irish Channel; and, from a Parliamentary return issued in 1815, we learn that, for the space of nine days in the previous year, only one packet could sail owing to adverse winds. In 1819, the passage of the sailing-cutters then employed averaged twenty hours from Holyhead to Dublin. In the summer of that year, however, the *Talbot*, of 156 tons, built by Wood of Port Glasgow, with engines of 30 horse-power each, by Napier, was placed on the station; and the *Ivanhoe*, of somewhat the same size, by Scott of Greenock, with engines also by Napier, followed in the course of the ensuing year.

Dublin and Holyhead Mail Packets.

The unexpected success of these steamers overcame the professional prejudices of the commanders of the sailing mail-packets, who had recently recorded as their opinion "that no vessel could perform the

winter passage with safety but sailing-cutters." The wish alone in this case must have been father to the thought, for, when the steamers *Royal Sovereign* and *Meteor* soon afterwards took up their station on the line, the cutters disappeared from it for ever. In fact, these steamers had so fully established the numerous advantages to be derived from the employment of vessels of this description, that, as early as 1823, a company was formed to carry on the communication regularly throughout the year by means of steam-vessels only. Subsequently, vessels superior to those of the class of the *Meteor* were constructed for this important service, and there were no faster or finer vessels of the period than the *Banshee* and the *Llewellyn*, which, in 1848, were placed on this station, having on their trial trips attained a speed of upwards of 18 statute miles per hour.[1]

Their great speed and regularity.

But the public soon required still faster and more commodious steamers; and a committee of the House of Commons appointed to inquire into the subject recommended the construction of vessels of 2000 tons each, with power sufficient to attain a speed of upwards of 20 statute miles the hour. Consequently, four ships were built, the *Connaught*, *Ulster*, and *Munster* by Messrs. Laird and Sons of Birkenhead, and the *Leinster* by Mr. Samuda of London.[2] The

[1] After the cessation of the sailing packets, and before the opening of the Holyhead Railway, the Dublin Mail was for some years carried *viâ* Liverpool by the City of Dublin Steam Packet Company.

[2] These celebrated ships are built of iron. The length between the perpendiculars is 334 feet; the beam is 35 feet, and depth 21 feet. There is a centre keel plate, 3 feet deep and $\frac{5}{8}$ inch thick, with two bars, 9 inches deep by $\frac{5}{8}$ inch thick, on each side at the bottom forming also the keelson; the plate, with the two garboard strakes, $\frac{7}{8}$ inch thick

engines of all these vessels are on the oscillating principle. In the two pairs constructed by Messrs. Ravenhill, Salkeld, and Co., for the *Leinster* and the *Connaught*, the cylinders are 98 inches diameter with a length of stroke of 6 feet 6 inches. The eight boilers are multitubular, four being at each end of the engine-room space, arranged in pairs,

Dimensions, power, capacity, and cost.

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each, are secured together with iron bolts riveted and countersunk. On the top of the centre keel plate, two angle-iron bars are riveted, 5 inches by 4 inches by ½ inch, and to these angle irons, and to the angle irons on the top of the floorings throughout the entire length of the vessel, as far as the fine ends will allow, is riveted a strong plate, 4 feet wide amidships, and 2 feet 6 inches wide at the ends. There are, also, two very strong box keelsons, secured on the floorings at each side of the keel, and another in each bilge. The engine bed-plates, paddle and spring beams, and all other beams for the main and lower decks, are of iron. Timber has been used only for the decks and cabin fittings. There are nine principal iron water-tight bulkheads, which not only provide for the safety of the ship in case of accident, but add greatly to her strength in a seaway. The bulwarks are of iron plates, in continuation of the sides of the vessel to the rail, and without any break for gangways, such not being required for landing either at Holyhead or at Kingstown. To give additional strength in the centre of the vessel, where the weight of the engines, wheels, and boilers has to be carried, the insides of the paddle-boxes are also formed of iron plates, continued from the sides and bulwarks of the vessel, with a strong bow girder, formed of an iron plate 15 inches broad and ¾-inch thick, so as to provide ample means of resistance to the severe shocks which these long vessels must encounter in rough seas, when driven at their high rate of speed. The gunwale is formed of angle-iron bars, 4 inches by 4 inches, riveted to the sheer strake and to a plate which is riveted on the top of the beams. At a distance of about 15 inches from this, an inner angle bar is riveted, against which the wooden waterway is fitted, so as to leave the outer part, between this and the gunwale, to form a drain to take the water off the deck, and to discharge it through the scuppers. This arrangement, which was introduced by the late Mr. John Laird, has been found very convenient in freeing the decks quickly from water. These iron gunwale plates are 5 feet wide by ¾ inch thick amidships, tapering gradually to about 2 feet 6 inches by ½ inch at the ends, with a system of diagonal tie plating from side to side, securely bolted or riveted to the deck beams. Between the paddle-boxes an upper deck, about 50 feet in length, has been placed.

with one funnel to each pair. The paddle-wheels are on the feathering principle, and are each 31 feet extreme diameter. On the trial trips the engines worked at the rate of 25½ revolutions per minute, under a steam pressure of 25 lbs. per square inch. The mean of the runs of the *Leinster* at the measured mile in Stokes Bay was at the rate of 20½ statute miles an hour, a greater speed by one mile an hour, than had up to this time (1860) been obtained by any other vessel in this country:—but the *Connaught*, when subsequently tried at the measured mile, attained a still higher result, the mean of her runs showing the speed of 20¾ statute miles per hour.[1]

The engines of the *Ulster* and *Munster* (constructed by James Watt and Co.) as well as their lines, very much resemble the other two, the main difference being that the diameters of the cylinders are each 96 inches, with 7-feet length of stroke. The internal arrangements of all the vessels are planned, with the object of providing for the comfort and accommodation of the public, in the way best calculated to mitigate, and, as far as possible, to prevent, the sufferings often accompanying the passage of the Irish Channel. In this and in most other respects, great success has attended the objects their designers had in view. Their saloons and cabins are large, lofty, and well ventilated; the principal one being upwards of 60 feet in length by 17 feet in breadth, and 9 feet 6 inches in height. Nor have these magnificent vessels failed to meet the require-

[1] Each of these vessels cost somewhere about 80,000*l.*, complete in all respects for sea.

ments of Government. The regularity of their voyages has been surprising;[1] and I am not aware of any loss of life or property which has occurred in connection with them since they started in 1860.

Dover and Calais Mail Packets.

Among the numerous other steamers now employed in the short voyage mail service, may be mentioned the small swift vessels running between Calais and Dover, Folkestone and Boulogne, Dover and Ostend, as well as between Southampton and the coasts of France, the Channel Islands, Jersey and Guernsey. They are beautiful boats of their class, and, considering their size and the rough weather they are frequently obliged to encounter, they perform their respective passages with remarkable speed and regularity. It is a rare occurrence for these packet-boats to be detained by a storm; and the manner in which they dash out of Dover or Calais harbours, at almost full speed, against a strong gale and an angry cross sea, shows that, if the British sailor has, from want of practice, deteriorated in seamanship, he has lost none of his native *pluck*. I know no more spirited and daring men than the masters of most of these small mail steam-packets, unless it be the Deal boatmen. They are cool and unruffled, while the smart little craft under their charge forces its way through the waves at the rate of twelve or thirteen miles an hour in the face of a gale which a landsman would describe as a "violent storm."

The *Victoria*.

Her speed.

On the next page is an excellent illustration of one of these vessels on her passage from Folkestone to Boulogne.

This smart vessel, the *Victoria* (well known no

[1] See Appendix No. 26, p. 644.

doubt to many of my readers), was built by Samuda, and her engines by Penn. On her trial trip over the measured mile, she attained a speed of 16½ knots or upwards of 18 statute miles an hour, which has been well maintained on the service in which she is engaged.[1]

S.S. "VICTORIA."

Proposed tunnel

These boats, however, are in their turn about to be superseded: at least, various other means have been suggested for crossing the English Channel between Calais and Dover. The two most gigantic schemes are a bridge over the channel and a tunnel below it, both having one chief object in view, relief from sea-sickness during that short, and, to most landsmen, very unpleasant passage. The bridge, though it had a few influential and enthusiastic supporters,

[1] The dimensions of the *Victoria* are as follows: length 200 feet, breadth 24 feet, and depth 12½ feet; she is 566 tons gross or builders' measurement; her engines are 220 horse-power nominal, and her draught of water 6½ feet.

appears to have been abandoned as wholly impracticable; but the tunnel is still contemplated, and experiments are now being made to ascertain the nature of the soil beneath the bed of the sea at the requisite depth. Its projectors, who are men of influence and experience, are sanguine of success, but as its cost will be enormous, though estimated at not more than one-half that of the Suez Canal, and, as it cannot be completed for many years, other plans have been in the meantime suggested, two of which have been already partially put in operation.

And other modes of crossing the straits of Dover.

It would be entirely beyond my province to offer any opinion as to the practicability of either a bridge or tunnel, but I shall endeavour to furnish my readers with a brief outline of the novel description of vessels now prepared to cross this narrow strait.

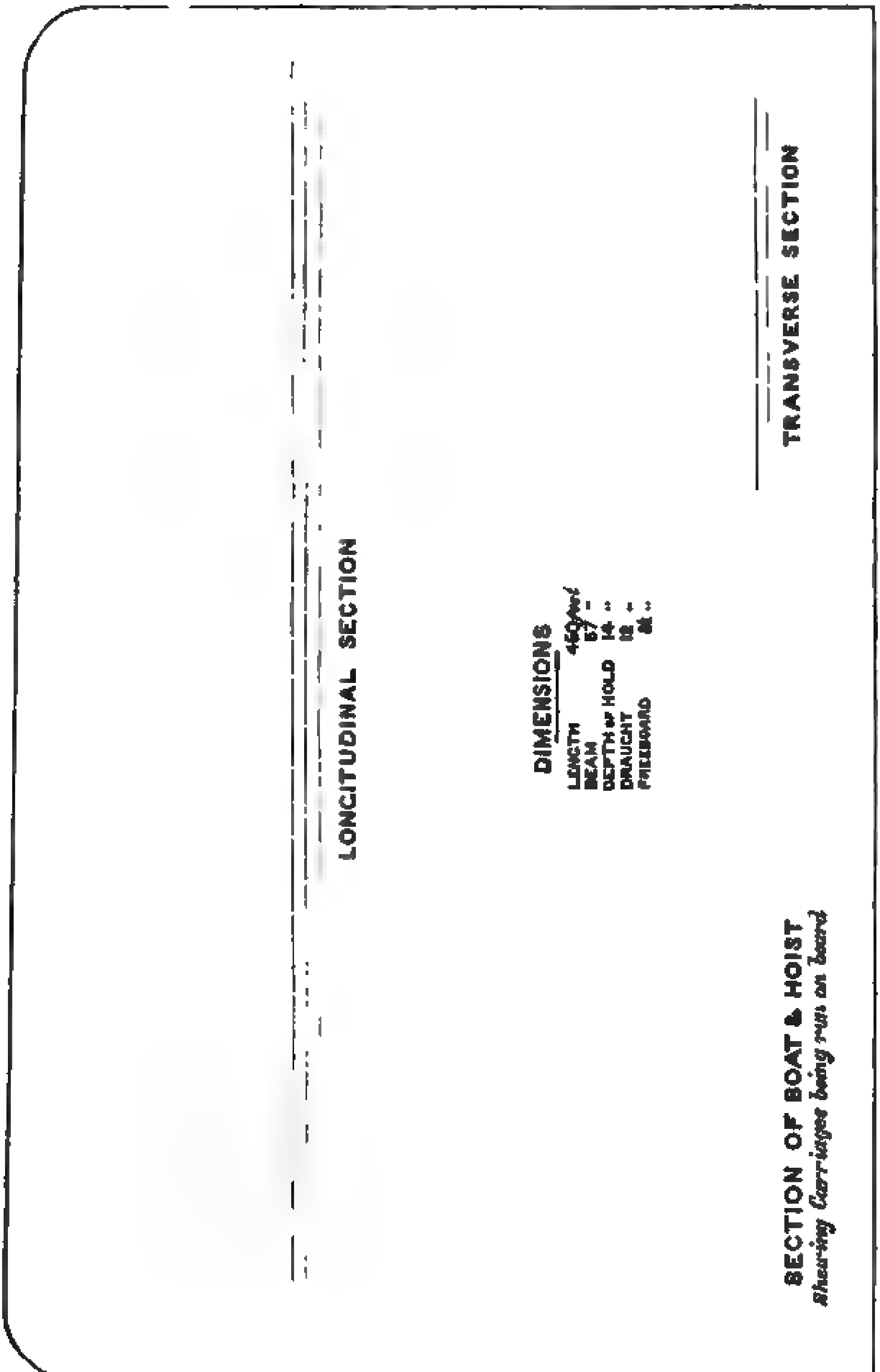
The question of bridging, tunnelling, or otherwise crossing the channel by easier modes than the existing mail packets has long occupied the attention of men of science, however much they may have differed with regard to the best mode of effecting the object in view. Among various modes, the one suggested by Mr. Fowler, C.E., in 1864, for which plans were deposited in 1865 and 1867, and which was fully brought before Parliament in 1872, seems to be well worthy of further consideration, embracing as it does the extension of the "through traffic" without change of carriage to all parts of the continent. This is one of the important objects sought to be achieved by the tunnel, but at four times the cost.

Mr. Fowler's plan.

Mr. Fowler proposes to build a steam-boat fit to receive a railway train complete, and carry it bodily across the channel from the South Eastern and

London and Chatham lines to those of the North Eastern of France. To effect this object, it will be necessary to increase, materially, the existing facilities of Dover Harbour, and to construct a new harbour on the French coast, of sufficient depth of water to receive, at all times of the tide, vessels of the dimensions he suggests. The transport of railway trains, by means of vessels across broad sheets of water, has, already, been proved to be practicable. The operation may be seen, not merely in various parts of the United States and on the Lake of Constance, but in Scotland, where "the North British Railway Company carry trains across an arm of the sea, five miles in width."[1] Nor is the plan suggested for connecting the steamers with the lines of railway, so that the carriages may run on board, either novel or impracticable. The ferry-boats of New York dove-tail, if I may so express it, into the end of a street and carry the whole of its traffic in one continuous line of passengers, carts, and waggons to Brooklyn, or across the Bay of New York to Staten Island and other more remote places: so that, in this respect, there is nothing visionary or impracticable in the scheme proposed by Mr. Fowler. Nor, so far as my nautical knowledge extends, are there any valid objections to it in other respects except the cost. There is no doubt that these vessels, from their immense weight, size, and speed, will realise every comfort by way of stability that can be attained in crossing the English Channel at its narrowest part, while their vast dimensions afford ample space for

[1] See evidence, Mr. Samuel Jack Mason, before the Committee of Lords on the International Communication Bill, 1872, pp. 49, 50, and 51.



CHANNEL PACKET PROPOSED BY MR. FOWLER, C.E.

every possible convenience to passengers, and, even, luxuries, if desired.

But in order that my readers may more clearly understand Mr. Fowler's proposal, I furnish (page 559) longitudinal and transverse sections of the boat he contemplates, with an illustration of the mode by which the carriages are to be transferred from the lines of railway on board the vessel, and, in a foot-note,[1] his explanatory remarks. Further explanations will be found in detail by reference to the evidence given before a Committee of the House of Lords, but the more important points of that evidence with the number of the question is supplied herewith.[2]

[1] The trains will come in from the South Eastern Railway and the London, Chatham, and Dover systems by independent lines to a central station. They will then be run on a hydraulic hoist, eight to nine carriages at a time, and this hoist will be lowered until the rails on it are exactly level with those on the steamer; a flap is then let down completing the communication between the rails on the hoist and the rails on the steamer, and the carriages are immediately hauled on to the steamer.

When the steamer enters the dock to receive the trains, she is run between rollers, fixed two on each side of the dock and allowing the least possible movement of the paddle-boxes sideways. Movements fore and aft of the steamer are prevented by buffers (similar to ordinary locomotive buffers) fixed at her end, which butt against recesses at the end of the dock, and also by blocks fastened to the dock wall which receives her end a little further aft, ordinary mooring apparatus keeping the ship tight up against the buffers.

In rough weather there may be a slight vertical movement when the head of the ship is next the hoist, but the flap which is let down, as before described, will be sufficient to accommodate this slight difference of level, which will be little more than is met with in passing over a turntable as in many railway stations.

No. of Question.		
[2] 49.	Length	450 feet to 470.
	Beam	95′ 0″ over paddle-boxes.
123.	Beam	57′ 0″ not including paddle-boxes.
156.	Depth	14 feet in hold from floor to ceiling.
153.	,, ...	34½ feet inner skin to hurricane deck.

The other boats, which have been already built, do not contemplate the transport of the railway carriages, but are simply meant to afford an easier mode of transit for passengers than at present exists.

The first, planned by Captain Dicey, formerly Master Attendant at the port of Calcutta, proposed, according to the prospectus issued by the company, "To provide ample accommodation for all classes of passengers under shelter as well as on deck; to reduce the motion of rolling and pitching of the vessel to a minimum; and to keep the draught of water of the vessel to 6 feet, so that she may enter the ports on either side of the channel at all hours of the tide."

To accomplish these objects, the company has built, at the Thames Iron Works, a ship named the *Castalia*, which may be roughly described as the two halves of a longitudinally divided hull, 290 The *Castalia*.

No. of Question.		
50.	Draught	12 to 13 feet.
513.	Freeboard	21′ 0″ to hurricane deck; 8′ 6″ main deck.
51.	Power	Two independent pairs of engines, one to each paddle, collectively of 1600 to 1800 nominal horse-power, 12,000 indicated horse-power.
167.	Speed	Twenty knots or 23 miles.
130. 274. 278.	Capacity for passengers .	Seventeen carriages, containing 336 passengers; or 2000 passengers, neglecting carriages.
132.	Cargo	22 trucks, say 180 tons goods.
68.	Cost of boats	£500,000 for three.

		£	
60.	Estimate for construction of harbour at Andrecelles, coast of France	700,000	
63.	„ for extension of Dover Harbour, &c.	1,000,000	
		£1,700,000	
	Cost of three steamers . . .	500,000	(?)
		£2,200,000	

feet long, placed 26 feet apart, and strongly bound together by a system of girders upon which is erected, as may be seen by the following woodcut, a raised deck inclosing cabin space. Under this deck in the water-way between the halves of the hull, work a pair of paddle-wheels side by side upon two separate shafts so that each wheel can be worked independently; these wheels are driven by two pairs of engines, one pair in each half of the vessel. The division and separation of the hull provides a deck of no less than 60 feet in width, with a stability much greater than any ordinary vessel possesses. Before and behind

CHANNEL PACKET "CASTALIA." (BETWEEN DOVER AND CALAIS.)

the engine, there are various state saloons inclosed by the hurricane deck, running the whole width of the vessel. These spacious rooms are handsomely decorated, and provide various comforts seldom attainable at sea, while the top platform affords a magnificent promenade 14 feet above the level of the water-line. There are, also, decks below running fore and aft to within a few feet of the double bow or stem in the separate hulls. The *Castalia* has accommodation for somewhere about 1000 passengers. Her estimated cost was only 60,000*l.*, but the actual outlay must have been considerably in excess of that sum. Captain Dicey states that, in

designing this vessel, he was in some measure guided by the performances of the "outriggers" that ply in the harbour of Galle—"long cranky boats hollowed out of tree-trunks, and steadied in the water by a log of timber fixed to the end of two wooden outriggers which project some way from the vessel's side."[1]

The other vessel, the *Bessemer*, is in many respects as different from all other steam-ships afloat as the *Castalia*; but was constructed with exactly the same objects in view, viz., to insure great speed, light draught of water, and, more especially, the smallest possible rolling or pitching motion. In a word, to afford to passengers crossing the channel the quickest means of transit with the greatest amount of ease, at an immersion so small, that the vessels could enter the existing English and French harbours at all times of the tide. This was the problem to be solved, and each inventor set about it in a wholly different way. Nor was this surprising, considering that each had

The *Bessemer*.

[1] Such vessels are well-known to Indian navigators; and, while carrying between 100 and 200 tons, ride steadily on a heavy swell that causes a large steamer to roll its ports under water. They are extraordinary looking craft, and are frequently to be found, not merely in the vicinity of Ceylon, but about the islands of the Pacific, and along the coasts of Northern India, as well as on the shores of Java and Sumatra, though nowhere else. The Indian boat, however, so far as I can judge, most resembling the steamer which Captain Dicey has built, is the *jangár* (not the *catamaran*),—a double platform canoe of the Cochin China backwater. The pontoons at Chatham are of a similar construction. To form the jangár, a floor of boards is laid across two boats, with bamboo railings 10 to 12 feet broad and 16 feet long; in these boats, native regiments, cattle, &c., are ferried across rivers. I may add, that the *catamarans* proper are constructed of three logs lashed firmly together, the centre one being the largest. They are usually from 20 to 25 feet in length, and from 2½ to 3½ feet only in width.

been trained in an entirely different school. The projector of the *Castalia* is a sailor of great nautical experience; the designers of the *Bessemer* are an engineer and iron worker together with a scientific shipbuilder. Perhaps, had the originators of the two schemes consulted, amicably, instead of entering on a needless rivalry, they would have produced a better and much swifter ship than the *Castalia*; and a considerable sum of money expended on experiments would also have been saved.

The *Bessemer*, of which an illustration is given on next page, was designed entirely by Mr. E. J. Reed (late Constructor to the Royal Navy), with the exception of the so-called "swinging saloon," and was constructed at Hull by Earle's Shipbuilding and Engineering Company: she is built entirely of iron, is a vessel of immense strength, and has, as may be seen from the illustration, very much the appearance of a breastwork turret ship of war. Her form is the same at bow and stern and, for 48 feet from each end, she has a freeboard of about 3 feet only. Her extreme length at the water-line is 350 feet, and the raised central portion, rising 8 feet above the low bow and stern, is 254 feet long, and, extending the whole width of the vessel, is 60 feet over all. The ends, as will be perceived, are very sharp and low. The engines and boilers, which drive the two pairs of paddle-wheels, are fitted in the hold at either end of the raised portion of the vessel. A series of deck-houses for private parties, refreshment bars, and other rooms are carried fore and aft of the paddle-boxes on the breastwork deck; there is, also, a covered walk between these and the windowed sides of the "swing-

S.S. "BESSEMER," BUILT FOR SERVICE BETWEEN DOVER AND CALAIS.

ing saloon," which rises about 8 feet through the breastwork deck, with a flat roof pierced by two companion hatches.

The nominal horse-power of the engines of the *Bessemer* is 750, but they can work up to an indicated power of no less than 4600, and were calculated to drive the vessel at a speed of from 18 to 20 statute miles an hour. The two pairs of paddle-wheels are placed 106 feet apart, and each wheel is 27 feet 10 inches in diameter, fitted with twelve feathering floats. Many of the inventions first produced in the *Great Eastern* have been adopted also in the *Bessemer*, such as hydraulic gear for starting the engines and for steering, telegraphic wires leading from the bridges to the engine-rooms, and various other ingenious contrivances to facilitate the working of the ship and her machinery.

Her swinging saloon.

The "swinging saloon," the invention of Mr. Bessemer, is in the centre of the vessel, and is entered by two broad staircases leading to a landing connected with the saloon by a flexible flooring. The saloon itself is upheld on its axis by four steel supports, one at each end and two close together in the middle. The aftermost of the two central supports is hollow, and serves as part of the hydraulic machinery for regulating the motion of the saloon itself, a spacious and elegant apartment 70 feet in length, 35 feet wide and no less than 20 feet high. It is presumed, that the hydraulic machinery will enable the person in charge of it to keep the floor of this cabin perfectly level, even when the ship herself is rolling violently in a heavy sea.[1]

[1] On Saturday May 8th, 1875, the *Bessemer* underwent what may

Such are the vessels contemplated to supersede the existing Dover and Calais packets. Although the *Castalia* has not realised the anticipated speed, and the *Bessemer* has been found altogether unsuitable for the service for which she was built, it would be premature to condemn even her as a failure, while the *Castalia*, from the comparative comfort she affords, is daily increasing in public favour. I have not, however, hesitated to furnish my readers with full particulars of these vessels, because they are interesting from their novelty, and no great strides have, hitherto, been made, as we have seen, in the art of ship-building or in the mode of propulsion, without the aid of men, who have been bold enough to enter on novel and, frequently, very costly experiments.

In these novelties, the Americans have, during recent years, taken the lead, and, on this subject, I cannot omit to mention one of the greatest mari- The cigar ship built at Baltimore, 1858.

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be called her first trial—that is, she crossed from Dover to Calais and back again. It would appear from the narratives in the different journals that she had nothing to contend with, on this occasion, in the way of weather or sea, and that, starting at 11.17 A.M. and reaching Calais Harbour at 12.45, her speed was about the same as that of the ordinary boats. Her greatest novelty, the saloon, was, however, not tried on this occasion. On this point Mr. Bessemer remarked, at a dinner given to him in Calais on the same day:—"I never dared to hope that, at first, this ship would be completely successful, so much depends on skill, and you must remember that there are no means whereby absolute automatic action can be given to the saloon, because there is no absolute point of stability. Within the ship we are like Archimedes who wanted a fulcrum for the lever that was to move the world; what we want is to place our fulcrum in an absolutely quiet spot. . . . In port the machinery will move with a degree of steadiness that is all that can be desired, the very reverse of this will take place at sea when the vessel itself moves and the cabin is required to be quiet: and, just as we require more practice to move the cabin in still water, so we require more practice to keep the cabin still in the moving ship."

Similar ship built on the Thames in 1864.

time curiosities of this age, the cigar ship built at Baltimore in 1858 by Messrs. Winans of that city,[1] who also, subsequently, built another somewhat similar vessel on the Thames. Her model in all respects resembled a cigar, or, in other words, she is a great iron tube tapering away to a point at each end, and presenting perhaps the strongest possible form for a ship, her deck being merely the arc of a circle, on which were riveted staunchions for rails, and between these a raised platform with seats on each side. She had neither keel nor cutwater, and, in the language of the inventors, there was "No blunt bow standing up above the water-line to receive blows from heavy seas, no flat deck to hold, or close bulwark (as in the case of ordinary vessels) to retain the water that a rough sea may cast upon the vessel; neither mast, spars, nor rigging." The absence of sails," they add, "not only renders the parts thus abandoned by us useless, but their abandonment in such a vessel as ours, will, we believe, most materially promote safety, easy movement, or diminished strain of vessels in rough weather; will save dead or non-paying weight, insure simplicity and economy of construction, and will give greater speed in smooth water, less diminution of speed in rough water as well as diminished resistance in moving power at all speeds in all water, and result in shortening the average time of making sea voyages. The length of our vessel," they continue, "is more than eleven times its breadth of beam, being 16 feet broad and 180 feet

[1] See *Harper's Weekly Illustrated Newspaper*, New York, October 28th, 1858, where drawings are given. I visited the cigar ship which was built at Milwall, London, in 1864, when she was ready for launching, and inspected her carefully.

long. This whole length is made available to secure water-lines, which are, materially, more favourable to fast speed, and also to diminished resistance to moving power of all speeds, than the water-lines of any of the sea-going steamers now built, the best of which, looking to speed and ease of movement, have a length of only eight times their breadth of beam: the portion of our vessel not immersed, has the same lines as that immersed, so that it will pass through the heaviest sea; while, from its form and construction, no water can be shipped that will sensibly affect the load, or endanger the safety of the vessel, which may, we believe, be propelled at its highest speed in rough weather with an impunity which is far from being attainable with vessels as now built, to be propelled wholly or in part by sails."

She was fitted with high pressure engines, and her boilers were on the principle of those used in railway locomotives. With regard to the propelling power it was a very novel application of the screw, being a ring to which blades were attached at certain angles to strike the water, the ring being itself made to revolve round the vessel with great rapidity by the engines fitted in the centre of the vessel; but Messrs. Winans do not furnish any further explanation beyond stating that "Its position is such that its minimum hold of the water will be much greater in proportion to the tonnage of the vessel than the maximum hold of the propelling wheel or wheels in ordinary steam-ships." In the illustration to which I have referred there will be found cross and longitudinal sections of this curious vessel.

These "cigar" ships appear to have failed through want of sufficient stability, or, more especially, on account of the novel and complicated character of their machinery, yet the facility with which they can be driven through the water may suggest a clue to further improvement in the construction of ships or at least in their form. There is, frequently, only a narrow line between the sublime and the ridiculous, and, in the scheme of a madman (called mad because he proposes something apparently wild and useless), there *may* be found the germ of really useful and grand inventions. Such fancies, therefore, ought not, in all cases, to be cast aside with contempt, even though they may create a smile from their novelty. Columbus was pronounced to be mad by the most learned men of Spain, when he talked of exploring the Atlantic in search of a world to the west. If Franklin, when he drew a spark of lightning from the clouds by means of his kite, had spoken about controlling that spark and rendering it the means of communication with other parts of the globe, all men would have called him mad.[1] Even the steamboat herself was long considered the dream of a schemer. Something useful may therefore still be learned from the plan of the "cigar ship," absurd as she may appear to the practical seaman. With these feelings I read the other day with great interest a prospectus brought casually under my notice of a plan

[1] Though lightning from the heavens has never yet been usefully employed, and is not likely to be so, the electricity generated in galvanic batteries and used for telegraphy is precisely the same as lightning.

for applying an improved steam-engine (patented by Messrs. Perkins and Sons, Engineers, London), to a vessel very similar in design to the cigar ship. The value of this "economical steam-engine," as it is termed, would seem to be the greatly improved principle adopted by the patentees in the construction of the boilers, which, they say, "will work with a pressure of steam of 300 lbs. to the square inch, and on a consumption of coal not exceeding 1½ lb. to the indicated horse-power per hour when working at full speed."[1] If anything like this can be really achieved, another surprising stride will be made in the path of progress. The Lords of the Admiralty, who have not hitherto been prone to adopt "novelties," appear to be of opinion that it can, as I understand that an engine has been ordered from the Yorkshire Engineering Company on Messrs. Perkins's principle, and is now in course of construction to be fitted on board her Majesty's ship *Pelican*, a sea-going ship of war.

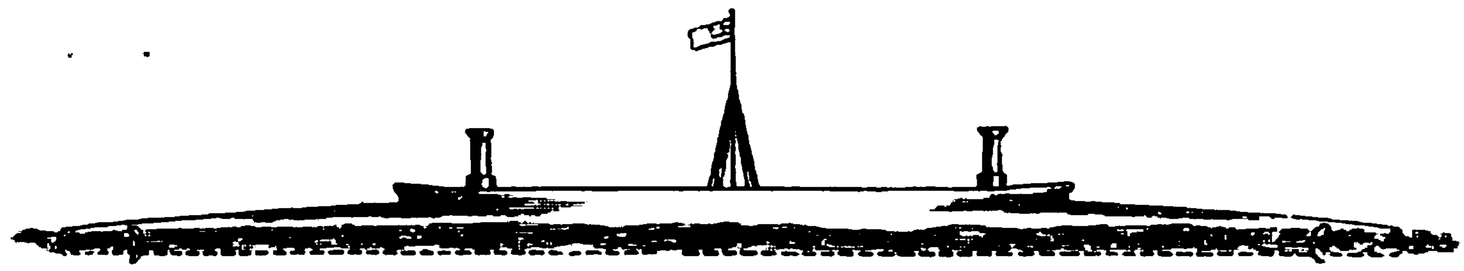
Perkins's economica steam-engine,

Combining this new principle with a form of hull somewhat resembling the cigar, Messrs. Perkins propose "to construct and run an experimental fast express steamer from England to New York for the speedy crossing of the Atlantic, by passengers and mails as well as parcels and light goods . . . with a light draught of water, great length and stability, and possessing steam power greatly in excess of any steam-vessel now afloat."

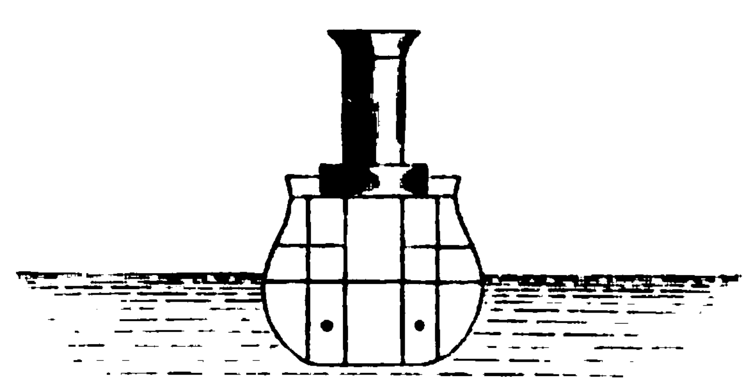
and proposed fast boat.

[1] Among other advantages the projectors offer an almost absolute safety of boilers from explosion, as they are made of 3-inch wrought-iron tubes ⅝ inch thick; the boilers when put together are proved to 2500 lbs. hydraulic pressure on the square inch, are worked from 300 lbs. to 500 lbs. per square inch as desired, and their bursting pressure is 20,000 lbs. per square inch.

The general design of the steamer they propose is represented as follows.



It is proposed that she should be 800 feet in length with 40 feet beam, and, having a flat bottom, it is calculated that she will not draw more than 11 feet of water with her cargo, passengers, and 500 tons of coal on board—the quantity estimated to be sufficient to take her from Liverpool to New York. The midship part of the ship, of which the following



is a transverse section, will, Messrs. Perkins state, be "400 feet in length, or about equal to that of a first-class Atlantic steamer of the present day; she is to have every modern convenience" to accommodate "1000 first-class passengers." "This vessel," the projectors add, "is to be fitted with four separate and distinct engines, working independent screws, two of which will be at either end of the boat; they are to be of the collective working power of 12,500 horses, calculated to make the passage either way in 100 hours;" at the average rate of 30 knots an hour.[1]

[1] Messrs. Perkins and Son base their calculations for speed on the fact that the vessel they propose will have 30 horse-power to a foot of

Considering the great resistance which the displaced fluids must offer to a speed on the ocean so enormous, it is not easy, with our present state of knowledge, to conceive its realization; but the projectors are sanguine of success, and, therefore, while recording the results of the past, I place before my readers such information as is likely to be interesting, or may proveuseful for the future. History is of little value, unless it teaches lessons to those who are to fill our vacant places, and, even at the risk of wearying my readers, I have for this reason gone more into detail than I should otherwise have done on such subjects, with a full conviction, that we have still very much more to learn, and especially as regards ships, than one man can hope to teach.

Though the different stages of improvement on the steam-ship have been carefully and fully recorded, it may be interesting to notice briefly the progress which has been made in the marine steam-engine itself. With that object I present my readers with a woodcut of the engine of the *Comet* constructed by James Watt and fitted into that boat by Mr. Robert- The Engine of the *Comet*.

midship section, the best Atlantic steamers having only from 4 to 5 horse-power to each foot of midship section.

I have submitted these particulars to a gentleman of great scientific and practical knowledge of marine propulsion, who remarks: "This large steamer is, I fear, a wild idea, until the form of the present steamship is very much improved. It will require a great deal more power than what Mr. Perkins proposes to drive such a vessel 30 knots an hour; and marine engines must be very much improved to get anything like this power in a ship, and to maintain it for 100 hours on a consumption of 500 tons of coal." But as everybody admits that we have not yet reached perfection, it is solely with the object of furthering improvement, that I furnish my readers with the plans and proposals of Mr. Perkins.

son, who is still living, and whose photograph accompanies the illustration. This famous machine is now exhibited at South Kensington, in the Museum of Patents.

This engine, which was a "high pressure" one, is simple in construction and light in weight, and,

"COMET" ENGINE.

though many improvements have been made since it first drove the *Comet*, to the wonder of the people on the Clyde, few of these changes have embodied any important principles. Although great strides have been made in the economy of fuel, and in the harmonious working of engines, the general principle of their action has undergone no change. By the

reciprocating movements of a steam impelled piston within a closed cylinder, the motive power of the modern steam-ship is obtained, as in the *Comet*; yet, probably, on no other subject has more mechanical ingenuity been lavished than on the marine engine. Twenty years ago, almost every engineer had his own peculiar type, comprising the "side lever," the "steeple engine," the "grasshopper," the "trunk," the "oscillating," and the "direct acting engine," with an endless variety of sub-combinations; but, after all, these were only variations in the engine left to us by Watt, which, a few years ago, might be seen in some of the small coasting craft plying between the Mersey and the Dee and elsewhere.[1]

Modifications in the construction of Marine Engines.

It was only when surface condensation and the compound principle were adopted, with improved boilers, and superior modes of raising steam and of more effectually applying its power, that the marine engine made any substantial advance. Thirty or forty years ago the usual pressure in a marine boiler seldom exceeded from 3 to 4 lbs. above that of the atmosphere, and, consequently, one of its most necessary fittings was a safety-valve opening inwardly, and called a "vacuum valve," so as to prevent the boiler collapsing if the steam pressure should chance to fall below that of the atmosphere,[2] but now the

[1] It will be remembered that the earliest application of the steam-engine was for the purpose of pumping water; hence, when applied to turn machinery, the great lever of the pumping engine was retained. The same thing took place on the application of the steam-engine to navigation; and, even now, the beam or lever engine is in common use both here and in America.

[2] A practical engineer, with whom I had recently some conversation on this subject, informed me that when, many years ago, he was superintendent of one of the oldest Steam Navigation Companies, it was

usual working pressure is 60 lbs., and 300 lbs. is the pressure to which many men of science think we are now advancing.

In a condensing engine, the effective pressure on either side of the piston is the steam boiler pressure *plus* the weight of the atmosphere due to the vacuum produced on the opposite side thereof.[1]

The boilers for this description of engine, being supplied with water from the sea, required frequent "blowing out" in order to prevent incrustation, and keep the water at a safe and regular density. But this "blowing out" process, which occasioned a very considerable loss in fuel, was to a great extent overcome by the introduction of the *surface* condenser, which produced fresh water; and this water is pumped back into the boiler to be again and again evaporated and condensed, thus dispensing with feeding from the sea. When the marine engine arrived at so comparative a stage of perfection, the public demanded increased speed, and when steam navigation was extended to distant stations, where fuel was costly, it became a matter of the greatest importance to still further economize its consumption; but considering that the speed of a steamship in relation to the power of the engines is subject to a ratio peculiarly its own (to double the speed of a

Ratio of speed to power.

scarcely possible to maintain a pressure sufficient to keep the air out of the boilers, and the hissing noise it made, when rushing into the boiler through the reverse valve, was a not unfrequent tell-tale of the slackened efforts of the over-worked fireman.

[1] To convert a quantity of water at 32 degrees into 10 lbs. of steam, requires 1 cwt. of coal; but to convert it further into steam at 40 lbs. pressure, would only require 1·012 cwt., and to raise it into even 90 lbs. not more than 1·024 cwt. of coal would be required.

ship the engines have to exert eight times the power necessary for the slower rate), the energies of the engineering world were severely taxed to obtain a greater speed on a less consumption. Higher pressures were introduced, and the principles of expansion more thoroughly worked out. It was known that, when steam from the boiler was cut off after the piston had traversed any desired portion of the cylinder's length, its expansive energy still enabled it to exert a considerable, though a necessarily decreasing, motive force upon the piston: that is to say, if steam of 50 lbs. absolute pressure were cut off at one-half the stroke, its elastic energy at $\frac{9}{10}$ths of the stroke would be 28 lbs., while the mean of its force throughout the whole of the stroke would be 42 lbs.: in other words, if the whole volume of steam in the cylinder, at the initial pressure, produced 50 lbs. per square inch, one-half of that volume, used expansively, would produce 42 lbs. per square inch.

To more effectually work out these principles and utilize the steam at high pressures, the compound engine was introduced, and is now, almost universally, adopted in the steamers of the mercantile marine.

The following woodcut shows an ordinary pair of direct acting inverted cylinder compound engines, as usually fitted in screw steamers.[1] It will be seen that they consist of two steam cylinders, one of

[1] The following illustration is from a photograph furnished by Messrs. T. Richardson and Son of West Hartlepool. It is exactly the same in principle as those supplied by Messrs. J. and G. Thompson of Glasgow, to the *Bothnia* and *Scythia*, belonging to the Cunard Company, which I have already described, and represents the usual construction of modern marine engines of the best class.

The Compound Engine small, and the other of large diameter. The steam from the boiler, at a high pressure, enters the small cylinder, and, thence, at the end of the stroke, passes, through an intermediate receiver, into the large cylinder acting upon its piston entirely by its

COMPOUND SURFACE ENGINE.

expansive force. At the conclusion of its double work, it passes into the surface condenser, and is there condensed into fresh water, producing the vacuum effect in the large cylinder.

The distinctive difference between the simple and the compound engine is that, in the former, the

work of the steam is begun and ended in the same cylinder, whereas, in the latter, it is begun in the small or high pressure cylinder and completed in the large or low pressure one; the work obtained in the small cylinder with the high pressure, and consequently the hotter steam, should be about equal to that in the large one with the lower pressure and cooler steam: in fact, it is the aim of engineers in designing a compound engine to proportion the cylinders and arrange the details of effecting the admission, expansion, and eduction of the steam, so that its pressure may be thoroughly utilized and as much work as possible obtained from it. Some engineers consider the simple engine to be more economical than the compound engine with the same pressure and total expansion; but I am informed, by those who have had opportunities of witnessing the performance of engines made on this principle, that, after a thorough trial in large ocean-going steamers, the anticipated results were not obtained from them, and that they were, consequently, replaced by compound engines.

But when the compound engine itself was first introduced, the high pressure and with it, necessarily, the high temperature steam, together with surface condensation, caused serious drawbacks to its efficiency, so that great changes had to be made in the internal arrangements of both engines and boilers. For instance, the high temperature produced great wear and tear in the cylinders, valves, valve faces, and so forth, while the boilers rapidly corroded under the influence of the feed water taken from the condenser. These evils, however, when more thoroughly under- more economical than the simple.

stood, were provided against; and the enormous saving in fuel induced shipowners to adopt the compound engines: under careful engineers, they last as long as, and cost very little more for repairs than the ordinary common condensing engines which consumed twice the amount of fuel.

It will, thus, be seen that the great stride in economy in the marine engine is due to high pressure steam expansion, and surface condensation: and, with a view to further economy, pressures are still advancing, the difficulty now being to construct a boiler that will withstand these pressures, and, at the same time, fulfil the other requirements of a marine boiler at sea. With these objects in view a number of patent water tubular boilers have been made. In 1870 and 1871 three ocean-going steamers were fitted with Howard's and one with Roots' patent boilers to work at a pressure of 120 lbs. per square inch, but they were not very long at sea before they failed, and were condemned. Again, in 1870, two very large steamers, each of 800 nominal horse-power, built for one of the Atlantic lines, were fitted with improved water tubular boilers to work at 120 lbs. pressure, but the trial of the first set of boilers, which completely failed, led the owners to condemn them and supply both vessels with those of the ordinary type to work at a pressure of 80 lbs. per square inch.

The failure of these boilers entailed an immense loss to the owners, and detained the vessels over twelve months, besides rendering the large engines, which were designed to work at 120 lbs., much less efficient at the lower pressure than they were intended to be.

It will, thus, be seen that the primary obstacle to advancement in economy appears to be the boilers, and although their construction, for very high pressure, is an expensive experiment, there are no less than four different descriptions (all of them patented) now being built in this country for marine purposes, any one of which, if thoroughly successful, will be another great step in advance.

However great the saving, hitherto, effected in fuel, there is still a wide margin between the means used and the effect produced, and great room, in other respects, for improvement. Indeed, Mr. Froude's late experiments, at the instance of the Admiralty, on the actual resistance of ships, show that, in the case of the *Greyhound*, the ship he experimented on, the efficiency, at a speed of 10½ knots, was only 51 per cent., showing a loss of 49 per cent. of the motive power, which was even greater when the speed was less.[1]

There remains, therefore, a very large and deeply interesting field of research; for, of all the heat produced, we utilise in the steam engine only a small proportion for the purposes of propulsion.[2] Nor have we yet reached perfection in our ships, so far as regards the best form for obtaining the

[1] See details in the Transactions of the Institution of Naval Architects, 1874.

[2] It may be stated, generally, that 1 lb. of coal can, under the most favourable circumstances, be made to evaporate from 12 to 16 lbs. of boiling water, the evaporation of each pound being equivalent to 745,800 foot-pounds of mechanical work. At this rate 1 lb. of coal ought to give out from nine to twelve million foot-pounds of work, while, in reality, no steam-engine does so much as two million foot-pounds for a pound of coal, so great is the loss from the want of proper means of utilizing the whole work produced by the combustion of the coal.—Vide Text-Books of Science, p. 174; by C. W. Merrifield, F.R.S.

greatest speed. I have already shown[1] that, in river navigation, the American steamers surpass in speed anything we have as yet accomplished; and that they have made various attempts towards the adoption of the flat floor or "skimming" process—in other words, to sail over the surface of the water rather than to force the ship through it, as in the case of the cigar ship and others.

Great skill required for building perfect ships.

To construct a perfect ship is itself a problem of the highest order, to which the attention of mathematicians and the knowledge, skill, and tact of naval architects have of late years been constantly directed, with as yet no examples of complete success, however much the ships of our own time surpass those of our forefathers. Nor can the construction of safe, effective, powerful, profitable, and durable engines and boilers for marine purposes be a matter of easy determination, as shown from the fact, that there are still continual failures, revealing many difficulties yet to be overcome. Again, the means of propelling the vessel through the water suggests questions as to the resistance of fluids, which hydro-dynamic science has hitherto failed fully to resolve. Finally, the combination of all these, so as to bring about to the greatest advantage the effect desired, is a still more arduous task which the skill of the naval architect, the mechanician, and the sailor, even when combined, has not yet overcome. To the perfecting of our steam-ships we must still continue to apply ourselves, if we would maintain the high maritime position we now hold; for it is, only, by the unwearied exertions of all who are employed in our varied branches of

[1] See *ante*, vol. iv. p. 150.

industry, and with the aid of wise and just laws, that England can hope to keep ahead of all other nations.

We have already, it is true, made extraordinary progress in the model and propulsion of our ships, but we have not yet approached perfection, nor shall we reach it, unless we continue earnest in our endeavours to do so. We know the properties of air, water, and electricity, and we have discovered the means of utilizing and directing these powers and of applying them to the most valuable purposes; yet, it is still necessary to carry in our steam-ships vast stores of coal—so great, on certain voyages, as to occupy much of the space otherwise available for cargo. So long, therefore, as this necessity exists, it cannot be said that we have reached anything like perfection.

and especial importance to England of having the best ships.

But her ships not yet perfect,

Nevertheless, we have made surprising advances, and have derived many inestimable advantages from the application of the power of steam to sea and river navigation, far exceeding the most sanguine anticipations, whether as the means of extending commerce with the various producing and manufacturing portions of the globe, or in promoting the advancement of civilization to less cultivated regions.[1] By steam navigation, the intercourse between maritime nations has already been facilitated to an almost incredible extent; while postal communication has been established between Great Britain and her extensive possessions in India, East and West, as well

[1] In the Appendix No. 27, p. 645, will be found the number of iron steam-vessels built and first registered in the United Kingdom in each year from 1861 to 1874; and the amount of British tonnage, steam and sailing, from 1850 to 1873, as compared with the United States, France, Holland, and Norway.

as with the United States of America, and, indeed, with all other countries. Even the most remote regions of Australia, China, and Japan have now a regular postal steam communication with Great Britain; we have doubled Cape Horn in our steamships, reaching the once distant shores of the Pacific in a space of time so short, and with certainty so unerring that, only a quarter of a century ago, the work performed would have been considered altogether impossible.

though great progress has been made during the last half century.

To enable us to secure these important advantages we have been greatly indebted to the invention and application of the screw to marine propulsion, for, without it, we should not have been able to undertake such remote voyages by means of steam, and without it, also, we certainly could not have successfully maintained them with profit and regularity; but there is still much to be done, and were we, in the pride of our achievements, however great they may be when compared with those of our forefathers, to assume that we have reached anything like perfection in Ocean navigation, our children would very likely have reason in their day to smile at our vanity.

LIST

OF

ARTICLES AND TABLES IN APPENDICES.

APPENDICES.

APPENDIX No. 1. Vol. iv., p. 50.

Robert Fulton.

In the life of Henry Bell by E. Morris (Glasgow, 1844), there is the following letter from Mr. Bell to a Mr. John McNeill. It is dated, Helensburgh, 1st March, 1824, and is as follows:—

"Sir, I this morning was favoured with your letter. In reply to your enquiry respecting the late Robert Fulton the American engineer, his father was a native of *Ayrshire*, but of what town or district there I cannot say. He went to America, where his son Robert was born."

As Ayrshire is my own native county, I was curious to ascertain if the Robert Fulton of whom Henry Bell writes was any connection of an old man named Fulton who rented a farm belonging to Lord Ailsa in the district of Carrick about four miles from the town of Ayr where I was born, and where also I was educated under a very dear uncle, the Rev. William Schaw, after whom I was named. Old Fulton (or rather old "Ballig," which was the name of his farm, and that by which he himself was better known) and his family were members of the United Presbyterian Church, of which my uncle was minister. On his ministerial visits to Ballig, I used, as a boy, frequently to accompany him, perhaps, more for the good fare which was produced on these occasions, than for anything else. Old Ballig or Fulton would be then (1827–1829) a man of somewhere about 80 years of age, and I remember he frequently spoke of an elder brother who had settled in America whose son became a "*great man.*" What that greatness consisted of, I do not recollect, but as it was something which in my boyish days had,

with the good fare, made a lasting impression on my mind, it came fresh to my recollection when I read the letter I have just quoted in the life of Henry Bell, and I wondered if the "great man," the nephew of old Ballig, was the Robert Fulton of world-wide fame.

Through my friend Mr. T. M. Gemmell, of Ayr, I ascertained that the grandson of the old man whom I knew now occupied the farm of Ballig. From this person, however, no reliable information could be obtained as to the position or fate of his ancestors. Perhaps, that was not surprising, as the schoolmaster does not appear to have paid many visits to Ballig since the days of my boyhood. Resolved to trace the matter still further, I applied to my friend and school companion, Mr. H. G. Reid, of H. M. Stationery Office, who, from his literary tastes as editor of his father-in-law's great work 'McCulloch's Commercial Dictionary,' readily lent me a helping hand. He, in turn, applied to his friends in Scotland, and among others to Mr. Cochran Patrick, of Woodside, in the parish of Beith, Ayrshire, where the Fulton family appear to have had their origin.

Mr. Patrick himself, a gentleman of considerable literary acquirements and fond of antiquarian research, heartily joined us on our voyage of discovery and, after some trouble, found a Mr. James Stevenson, residing on his own property in Lochwinnoch, who said he knew all about the Fulton family, and who made the following statement in writing, which I give in his own words as follows:—

"*Knows*, 31*st March*, 1875.

"Robert Fulton was born at Mill of Beith, parish of Beith, Ayrshire, in the year 1765. His father, William Fulton, was born at Threepwood, also in the parish of Beith, about the year 1720. He took a lease of Brownmuir and Mill of Beith, corn mill, about the year 1742. He married Rose Mitchell, a native of Dumbarton, in the year 1744. He had issue five daughters and two sons. The eldest son, William, was born about the year 1747 or 1748; he became a partner in the firm of Fulton, Buchanan, and Pollock, who erected a large cotton mill in Lochwinnoch. William Fulton was manager, and carried on the engineering connected with the mill. Among the workmen employed were the late William Dunn of Duntocher, and Henry Bell of Glasgow. Robert Fulton, when young, was educated in the highest branches of learning, being master of nine different

languages. He had a cousin, Henry Fulton, in Londòn, who had a warehouse, and Robert's father intended him to go there. He was educated so that he might be able to transact business with foreign merchants. He went to London about the year 1788, but he did not like to be confined in the warehouse or office. He went to sea many different voyages, was at Greenland, America, and the Indies. He was often in London, and came different times to Scotland to see his father, mother, and his brother and sisters, and also got models and machines made by his brother's workmen at Lochwinnoch for some of his inventions. He was in Scotland about the year 1801, and visited a steam-boat in the Forth and Clyde Canal along with Henry Bell. He was about London after that. He had inventions of different things, which he made offer of to the British Government, but they would give him no encouragement, after that he went to Paris and made offer of them to Bonaparte. The British Government, hearing that he had made offer of them to Bonaparte, issued an order for his apprehension. He was in Paris about the year 1803, and left for America in company with the American Consul Livingston. He got acquainted with his daughter or niece, Harriet Livingston, in the vessel, and was married to her in a short time after. It was after that that he started the steam-boat on the Hudson River. He had been at great expense and got into difficulties for want of money. He left America and went to Antigua, and commenced business, and remained there, except when visiting his friends in Scotland. I recollect him being here, in this house, visiting my father and mother, my sister and elder brother very well recollect the same; it was in the year 1821. He returned to Antigua and died in about a year after that; also his wife died about a year after him. His will and settlement came home and was in the hands of Martin and Simpson, writers, Paisley; the way I know this he was uncle to both my father and mother, their mothers being both sisters of Robert Fulton.

"The few statements herein contained are within my own knowledge.

"JOHN STEVENSON."

By this very distinct statement, it appeared we had discovered that the celebrated Robert Fulton was not merely of Ayrshire parentage, *but was himself born in Ayrshire,* a fact, if substantiated, of no ordinary importance to us as Scotsmen, who, proud of our countrymen Watts and Symington, could now

rank with them as a countryman also of our own, the only rival claimant, of note, to the invention of the marine steam engine. It may have been the case that he was a renegade, who having propounded to Napoleon a scheme for the invasion of England, had disowned the land of his birth, and sought protection as an American subject—an opinion, however, which tended to confirm our belief that the Robert Fulton of engineering fame was *really* a Scotsman. Indeed, considering the statement made by Mr. Stevenson, there were many reasons for supposing that such was the case; and our belief was strengthened when, on searching the parochial register of the parish of Beith, deposited in the General Register House, Edinburgh, we found the following entry: "Robert, lawful son to William Fulton and Rosie Mitchell in Miln of Beith, April 17th; baptised April 22nd, 1764." The only real differences (apart from the dates 1764 instead of 1765, in the statement) which required to be cleared up, was his death in Antigua in 1821, instead of in New York in 1815, as stated by his biographers, and, also, the fact of his marriage to Miss Livingston. To ascertain these points I communicated with the Governor of Antigua, who courteously obtained and forwarded, in due time, a copy from the register of the parish of St. George in that island of the entry of the death of a Robert Fulton at the age of fifty-three, and his burial on the 25th November, 1819. As this Robert Fulton was buried two years before Mr. Stevenson saw the Robert Fulton of whom he speaks, as the copy of his will which the Governor of Antigua was also good enough to obtain, makes no mention of the name of Livingston, and as no record could be found of the death in that island of any other person of the name of Robert Fulton, we reluctantly arrived at the conclusion that, after all, we had not found the man for whom we had made so diligent a search.

The incidents in the lives are, however, so much alike, that they are worthy of record, and may give my readers some idea of the labours of an author to arrive at the truth; labours which are frequently made in vain, as in the present instance. But, though the Fulton from Beith was apparently not the Fulton of fame, I have a strong impression that the nephew of my old friend Fulton of Ballig was so, though I have not the time, at present, to make further researches, as this volume is now on its way to press.

W. S. LINDSAY.

Shepperton Manor, Nov. 1875.

APPENDIX No. 2. Vol. iv., p. 69.

Dredging Machines of the River Clyde Trust, with their Dimensions, Cost, and Power.

The plant is made up as follows:—

6 steam dredgers,
14 steam hopper barges,
1 steam tug,
3 diving bells,
270 punts, and numerous small boats.

The value of the whole plant is estimated at 140,000*l.*

General Dimensions of Largest Dredger:—

	Ft.	In.
Extreme length	161	0
Depth at sides amidships	10	0
Breadth moulded	29	0
Rise of deck at centre	0	10
Sheer of deck	2	3

One bucket ladder, 89 ft. 6 in. between centres.
Size of buckets, 3 ft. 3 in. × 2 ft. 5 in. × 1 ft. 11 in.
Capacity of buckets, 13½ cubit ft. each.
Mean working draught, 6 ft. to 7 ft.

Engines.—Horizontal, condensing, 2 cylinders with link motion, governor, and all recent improvements, say 75 H.P.

	Ft.	In.
Diameter of cylinders	2	3
Length of stroke	3	0

Average strokes per minute, 33.

Boiler.—Horizontal, tubular, with 3 furnaces, each 3 ft. 1½ in. wide.

	Ft.	In.
Length at bottom	9	4
Width	11	4
Height	13	10

Working pressure of steam, 10 lbs. to 15 lbs. per square inch.

Consumption of coals, &c.:—

Coals, per day of 10 hours	50 cwts. to 60 cwts.
Tallow „ „	about 1 lb.
Oil (lard) „ „	13½ gills.
Waste „ „	1½ lb.

Nos. 11, 12, 13, and 14. STEAM HOPPER BARGES.

General dimensions:—

	Ft.	In.
* Length of keel and fore rake	145	0
Breadth, moulded	25	0
Depth, ditto	11	9
Length of hopper	56	0
Breadth of ditto at deck	19	6
Ditto ditto bottom	8	6
Height of coamings at sides of hopper	1	4

Capacity of hopper, about 320 cubic yards, or 400 tons.

Engines, &c.—Direct acting, condensing, 2 cylinders, each 24 in. diameter and 24 in. stroke. Expansion valves, link motion, &c., say 40 H.P.

Propeller, 3 bladed, 8 ft. diameter, pitch about 16 ft.

Boiler.—Cylindrical, 11 ft. diameter, and 9 ft. 6 in. long, tubular, fitted with superheater, 2 furnaces, working pressure, 30 lbs. per square inch.

Draught, speed, &c.—Loaded, with sand, 9 ft. 6 in. forward, and 11 ft. 6 in. aft. Light, boiler full, and 20 tons to 30 tons of coal in bunkers, 4 ft. forward, and 8 ft. 2 in. aft.

Speed, 8 miles to 9 miles per hour.
Strokes of engine, average 70 per minute.
Steam pressure, 25 lbs., vacuum, 24.

Consumption of coals, &c.:—

Coals, per day of 10 hours	70 cwts.
Tallow " "	5 lbs.
Oil " "	20 gills.
Waste " "	2 lbs.

"The cost of dredging, of course, varies much according to the character of the material to be lifted, and to the power of the dredger employed and the capacity of its buckets. The material to be dredged ranges from silt and sewage deposit to the hardest of gravel and boulders, completely concreted together. Where good lifting sand was being dredged, one of the two most powerful of the dredgers lifted, on each of five consecutive days, 2240 cubic yards, or about 2800 tons; the engine working 9 hours the first day, 9¾ hours the second, third, and fifth days, and 9¼ hours the fourth day; the average strokes of the engine being 33 per minute, and the average depth of water that the points of the buckets were working at, 20 ft."

Ships Launched on the Clyde, 1863–74.

The following return is from the Report, for 1873, of Mr. Wm. West Watson, Chamberlain to the City of Glasgow.

Year.	Amount of new Tonnage launched during the year.	Amount of new Tonnage on the Stocks or under contract at 31st Dec. of each year.
1863	124,000	140,000
1864	178,505	105,957
1865	153,932	109,404
1866	124,513	71,869
1867	108,024	124,082
1868	169,571	134,818
1869	192,310	140,999
1870	180,401	180,175
1871	196,229	301,809
1872	230,347	247,345
1873	232,926	192,608
1874	262,430	182,303

New Vessels launched on the Clyde during the Year 1874.

	Nos.	Tons.	Nos.	Tons.
Iron Steamers under 100 tons each	14	543		
„ from 100 to 500 tons each	25	7,621		
„ „ 500 „ 1000 „	29	19,121		
„ „ 1000 „ 2000 „	23	36,029		
„ „ 2000 „ 3000 „	25	61,202		
„ „ 3000 tons and upwards	19	70,969		
			135	195,485
Iron Sailing Ships, under 500 tons each	1	415		
„ from 500 to 1000 tons each	12	8,867		
„ „ 1000 „ 2000 „	37	56,266		
			50	65,548
Composite Steamer	1	100		
„ Gunboats for the British Government	2	656		
			3	756
Composite Sailing Ship			1	241
Iron Canal Lighter			1	100
Iron Steam Launches			3	30
Iron Hopper Barges			2	140
Wooden Schooner			1	130
			196	262,430

The returns from which this table is constructed were obtained confidentially from the respective builders, and I may add that the value of the vessels specified above may be assumed, notwithstanding a fall of from 2*l.* to 3*l.* a ton, when compared with the value in the year 1873, as amounting, in round numbers, to the enormous sum of nearly 6,500,000*l.* sterling.—*Note by Mr. William West Watson, Chamberlain of the City of Glasgow.*

APPENDIX No. 4. Vol. iv., p. 71.

Shipbuilders on the Clyde, from 1st January to 31st December, 1871.

The following return from the 'North British Daily Mail' of 1st January, 1872, includes not merely the vessels built at Glasgow, but also at Greenock, Port-Glasgow, Dumbarton, and other places on the Clyde.

Names of Builders.	Steamers.	Sailing Ships.	Tonnage.	H.P. Nominal.
John Elder & Co., Fairfield	12	2	31,889	5,275
Caird & Co., Greenock	6	..	18,400	2,820
William Denny & Brothers, Dumbarton	7	..	14,921	1,810
Archibald M'Millan & Son, Dumbarton	7	..	9,720	500
London & Glasgow E. & I. S. Co., L., Glasgow	8	..	8,740	1,220
J. & G. Thomson, Govan	6	..	8,715	1,040
A. Stephen & Sons, Linthouse	5	2	8,529	965
Henderson, Coulburn, & Co., Renfrew	11	..	7,386	1,200
Aitken & Mansel, Whiteinch	7	4	6,760	840
Blackwood & Gordon, Port-Glasgow	7	..	6,284	870
Barclay, Curle, & Co., Stobcross and Whiteinch	7	1	6,070	500
Robert Duncan & Co., Port-Glasgow	4	..	5,726	1,528
R. Napier & Sons, Govan	5	..	5,709	860
Charles Connell & Co., Scotstoun	3	..	5,560	385
Tod & M'Gregor, Patrick	2	..	5,500	710
William Simons & Co., Renfrew	7	..	5,450	1,050
Scott & Co., Greenock	7	..	4,900	710
J. G. Lawrie, Whiteinch	4	1	4,760	800
John Reid & Co., Port-Glasgow	..	5	4,620	..
Robert Steele & Co., Port-Glasgow	8	..	4,389	611
A. & J. Inglis, Pointhouse	6	2	4,322	730
Henry Murray & Co., Port-Glasgow	14	..	3,780	569
Dobie & Co., Govan	5	..	3,445	450
Thomas Wingate & Co., Whiteinch	12	5	2,947	395
William Hamilton & Co., Port-Glasgow	3	..	2,304	308
J. & R. Swan, Dumbarton	6	5	2,000	230
Cunliffe & Dunlop, Port-Glasgow	4	3	1,381	210
Thomas B. Seath & Co., Rutherglen	6	9	1,000	100
Irvine Shipbuilding Co., Irvine	..	4	973	..
John Fullarton & Co., Paisley	4	..	916	173
Robert M'Lea, Rothesay	..	5	700	..
J. & J. Fife, Rothesay	..	17	..	..
Scott & M'Gill, Bowling	2	1	200	20
William Fyfe & Sons, Fairlie	..	3	175	..
Peter Barclay & Sons, Ardrossan	..	1	117	..

Note.—No reliable return similar to the above has been compiled since 1871 of the names of the builders, and the number of ships built by each firm, but the aggregate amount of tonnage launched on the Clyde each year since then, inclusive of 1874, has been quite as great (see preceding page), though the proportion to each builder has of course materially varied.

APPENDIX No. 5. Vol. iv., p. 71.

Shipbuilding on the Wear, from the 1st January to the 31st December, 1874.

The following return from the 'Sunderland Times' includes all the vessels built at Sunderland and places in the immediate vicinity on the River Wear for the above year.

IRON SHIPS.

Builders' Names.	Ships' Names.	Tons.	Class A 1.	Port of Register.
Austin and Hunter .	Barambio	754	90	Bilboa.
,, ,,	Knight Templar . .	1546	90	North Shields.
Bartram, Haswell & Co.	Cumbria	675	100	Scarbro'.
,, ,,	Clan MacLeod. . .	671	100	Glasgow.
,, ,,	Stag	1558	90	North Shields.
Blumer, J., and Co. .	St. Peter	753	90	Sunderland.
,, ,,	Waikato	1053	100	London.
,, ,,	Dacca	1153	100	,,
,, ,,	Waitangi	1161	100	,,
,, ,,	Blyth	751	90	North Shields.
,, ,,	Waimate	1157	100	London.
,, ,,	Fernglen	850	100	Sunderland.
Doxford, W., and Sons	Yen-tai	947	100	London.
,, ,,	Broomhall	1430	100	Dundee.
Laing, James . . .	Kashgar	2621	100	London.
,,	St. Lawrence . . .	2220	100	,,
,,	Formosa	1024	100	,,
Mounsey and Foster .	Roderick Dhu . .	1723	100	Liverpool.
,, ,,	Santander	709	90	Newcastle.
,, ,,	Imbro	1222	90	Sunderland.
,, ,,	Eastern Monarch . .	1769	100	London.
,, ,,	Senator	1768	100	Liverpool.
,, ,,	Duchess of Edinburgh	1766	100	London.
,, ,,	Dunalistair. . . .	1756	100	Dundee.
,, ,,	Linguist	1601	100	Liverpool.
Osborne, Graham & Co.	Lolland	557	90	Nakskov, Denmark.
,, ,,	Andes	866	100	Hull.
,, ,,	Alexandra	797	90	Newcastle.
Oswald and Co. . .	Idomene	1424	100	Liverpool.
,, ,,	Respigadera . . .	1629	100	,,
,, ,,	Foyle	1662	100	London.
,, ,,	Fitzclarence . . .	917	90	Glasgow.
Pile, W., and Co. . .	Barossa	1019	100	London.
,, ,,	Rodney	1519	100	,,
,, ,,	Olive	885	100	,,
,, ,,	Plassey	1764	100	,,
Short Brothers . . .	Arizona	1288	100	North Shields.
Simey, A., & Co. . .	Stag	1048	90	W. Hartlepool.
Thompson, J. L. . .	Florence Richards .	1051	90	Maryport.
,,	S. W. Kelly . . .	1064	100	Cardiff.
,,	Romulus	1442	90	Sunderland.

Shipbuilding on the Wear, from the 1st January to the 31st December, 1874.

IRON SHIPS.

Builders' Names.	Ships' Names.	Tons.	Class A 1.	Port of Register.
Thompson, J. L.	Remus	1447	90	Sunderland.
,,	John Howard	1237	100	Cardiff.
Thompson, R., jun.	Lochnagar	1597	90	Aberdeen.
,,	Theseus	1041	100	London.
,,	Min	1411	100	,,
,,	Rayner	1155	90	Newcastle.
Watson (creditors)	Ballochmyle	1511	100	Greenock.
,, ,,	Baron Aberdare	1708	100	,,

There are several large vessels at present fitting out, but as they have not yet been classed, they are not included in Lloyd's List for this year.

Classed at Lloyd's only.

WOODEN SHIPS.

Builders' Names.	Ships' Names.	Tons.	Class A 1.	Where sold to.
Crown, John	Unkomanzi	333	11	Aberdeen.
,,	Robina Dunlop	512	12	Glasgow.
,,	Transvaal	384	12	Aberdeen.
Gardner, James	Truth	527	13	Liverpool.
,,	Campsie Glen	510	12	North Shields.
,,	Aydon Forest	522	12	,,
Gibbon, N.	Nancy Holt	328	12	Liverpool.
,,	Lanercost	562	12	Sunderland.
,,	Tonga	314	12	London.
,,	Mary Frost	325	12	Liverpool.
,,	Coomassie	428	12	South Shields.
,,	Glen Ville	325	12	London.
Gibbon and Sons	Violet	170	11	Sunderland.
,, ,,	Emily McLaren	445	12	Greenock.
Gill, John	Zeeburg	533	12	,,
Pickersgill, Wm.	Thomas C. Seed	296	12	Fleetwood
,,	Florence and Margaret	302	12	,,
,,	William D. Seed	757	12	,,
,,	Emma Crook	305	12	,,
Richardson, W.	Pauline	472	11	Newcastle.
,,	Swallow	309	11	Dartmouth.
,,	Chittagong	335	11	London.
Thompson, Rich.	Adeliza	297	11	Fleetwood.
,,	Silver Cloud	304	12	London.
,,	Our Annie	377	12	Fleetwood.

Ships building on the Wear, for the Quarter ending September 30, 1875.

Intended for classification in Lloyd's Register of British and Foreign Shipping.

WOODEN SHIPS.

Name of Builder.	Tons.	Progress.	Class A.
Crown, John	700	Planked and caulking . .	*13
Dunn, G.	50	Planked	8
Gardner, J.	650	Nearly framed	12
"	100	Planked	10
Gibbon, N.	340	"	12
"	300	Laying down	12
Gibbon, J., and Sons	250	"	12
Pickersgill, William	300	Launched	12
"	300	Keel laid	*12
Richardson, W.	280	Fitting out	12
Thompson, Richard	330	Nearly ready to launch . .	12
"	490	Framed	12

COMPOSITE SHIPS.

Name of Builder.	Tons.	Progress.	Class A.
Laing, James	1200	Planked and decked . . .	16
Thompson, R., jun.	800	Keel laid	16

IRON SHIPS.

Name of Builder.	Tons.	Progress.	Class A.
Austin and Hunter	900	Launched	100
" "	700	Building frames	*100
" "	1000	Commencing	100
Bartram, Haswell, and Co. . .	900	Launched	100
" " " . .	1200	Plated	90
" " " . .	800	Framing	100
" " " . .	650	Commencing	100
Blumer, J., and Co.	1100	Preparing to launch . . .	90
" "	500	Plating	100
Doxford, W., and Sons . . .	2700	Nearly ready to launch . .	100
" " . . .	2700	Plating	100
" " . . .	650	Ready to launch	100
" " . . .	1700	Framing	90
" " . . .	700	Not commenced	100
Gulston, G. S.	700	Ready to launch	90

IRON SHIPS.—*continued.*

Name of Builder.	Tons.	Progress.	Class A.
Laing, James	2700	Framed and standing	*100
"	2700	Not commenced	*100
"	1400	Ready for sea	90
"	620	Not commenced	100
Mounsey and Foster	800	Launched	100
" "	800	Plated	100
" "	800	Plated	100
Osbourne, Graham, and Co.	1320	Ready to launch	100
" " "	780	In frame	100
" " "	1340	Laying down	100
Oswald, T. R.	1470	In frame	100
"	1420	Fitting out	100
Short Brothers	1500	Plating	100
Simey and Co.	875	Finishing	90
Thompson, Robert, jun.	500	Finishing	100
Thompson, J. L., and Sons	600	Preparing material	100
Watson, W. (creditors)	1600	Framed	100

Vessels sold	41
" *unsold	5
" building	46
Tonnage	44,115 tons
Total last quarter, 57 vessels, of	57,803 "

LIVERPOOL UNDERWRITERS' REGISTRY FOR IRON VESSELS.

List of Vessels building on the Wear, for the Quarter ending September 30, 1875.

Name of Builder.	Tons.		Progress.
Jas. Laing	1164	S. S.	Completing.
"	1000	S. S.	Completing.
"	1250	S. S.	Completing.
"	900	S. S.	Plating.
"	900	S. S.	Plating.
"	800	S. S.	Plating.
"	600	Barque	Commencing.
T. R. Oswald	1900	Ship	Fitting out.
"	1830	Ship	Completing.
"	1630	Ship	Plating.
Short Brothers	1200	S. S.	Completing.
Wm. Doxford and Sons	1000	Barque	Completing.
Mounsey and Foster	900	Barque	Completing.
Austin and Hunter	900	Barque	Completing.
Osborne, Graham, and Co.	1200	Ship	Commencing.
G. S. Gulstan	900	S. S.	Completing.

The following table shows the number of ships built each year on the Wear since 1858, with the aggregate and average tonnage.

Year.	No.	Tons.	Average Tons.	Year.	No.	Tons.	Average. Tons.
1858	110	42,003	381	1867	128	52,249	408
1859	100	37,184	371	1868	138	70,302	$509\frac{1}{2}$
1860	112	40,201	358	1869	122	72,420	$585\frac{1}{5}$
1861	126	46,778	371	1870	103	70,084	$680\frac{1}{2}$
1862	160	56,921	355	1871	97	81,903	$844\frac{1}{3}$
1863	171	70,040	410	1872	122	131,825	$1,080\frac{1}{2}$
1864	153	71,987	470	1873	96	100,324	1,045
1865	172	73,134	425	1874	95	99,731	$1,049\frac{3}{4}$
1866	145	62,719	432				

APPENDIX No. 6. Vol. iv., p. 96.

Relative Weight and Strength of Wooden and Iron Ships.

Forty years ago the relative general difference between the weight of wooden and iron vessels may be fairly taken as stated by Mr. Laird in his evidence; but, inasmuch as iron ships have gone on since that date increasing in length, and wooden ships rarely exceeded 5½ times their beam, the weights relatively have increased, and may now be taken in a vessel of the same tonnage as 6–10 against wooden ships of a high class which would be built of timber of high specific gravity. As the weight of timber varies from 45 to 64 lbs. per cubic foot, the weight of a ship is consequently regulated by her class, as also by her length; and as a ship of ten times her beam must necessarily be built of heavier scantling than one of the same register tonnage, a long and high-class ship will necessarily be of greater weight than a short vessel of inferior description.

In an interesting paper on the strength of iron ships, by Mr. William John, Assistant Surveyor of Lloyd's Registry, which will be found among the Transactions of the Institution of Naval Architects for 1874, that gentleman gives the weight of iron ships of superior class, under 340 feet in length, and of 2500 tons burden, as 1596 tons.

APPENDIX No. 7. Vol. iv., p. 146.

Description of Machinery and Boilers of the American coasting Steamers "Bristol" and "Providence."

Beam Engine.—Cylinder, 110 in. diameter, with a stroke of 12 ft. Balance, puppet valves, with adjustable drop cut off. Surface condenser, with 8500 square ft. of tube surface. Bucket and plunger circulating pump connected with beam.

Paddle-Wheels.—Of iron, 39 ft. 6 in. diameter, with a face of 12 ft. Wheel-shaft, 21 in. diameter.

Boilers.—Three in number, extending fore and aft the vessel in the hold. Fire-room, athwart ship. Boilers of the flue and tubular type; with double tier of furnaces, one above the other, on the plan for which the constructing engineer has a patent. Shell of boilers, back of furnaces, circular. Extreme length, 35 ft. Diameter of round shell, 12 ft. 5 in. Width of furnace front, 12 ft. 7 in. Number of furnaces in each boiler, four. Interior of boilers, flues below, and 5-in. tubes above.

Total amount of fire-surface . . . 13,800 square ft.
Grate-surface . . . . 510 „ „
Pressure of steam carried, 25 lbs. to square inch.
Effective horse-power, 3000.
Speed, 18 to 20 miles per hour.
Engines and boilers designed by Erastus W. Smith of New York.

The engines of the *Bristol* and *Providence* are believed to be the largest single marine engines afloat in any part of the world.

APPENDIX No. 8. Vol. iv., p. 219.

(Transatlantic Steam.)

Comparative Statement of average Sailings of Collins and Cunard Lines for the second half of the Year 1851.

The following is extracted from 'The New York Courier and Engineer:'—

But the Cunard Company themselves give the following returns of the sailings of their steamers:—

Collins Line—14 trips, Liverpool to New York.

	Days.	Hrs.	Min.
Total time occupied . . .	158	21	15
Average time per trip . .	11	8	..
Quickest trip by "Baltic" .	9	13	..
Longest trip by "Atlantic"	13	17	30

Cunard Line—13 trips, Liverpool to New York.

	Days.	Hrs.	Min.		Days.	Hrs.	Min.
Total time occupied . . .	161	4	15	.. ..	155	17	26
Average time per trip . .	12	9	..	.. ..	11	23	30
Quickest trip by "Africa"	10	6	..	"Africa"	10	10	50
Longest trip by "Europa" .	16	20	..	"Europa"	17	2	50

Collins Line—13 trips, New York to Liverpool.

	Days	Hrs.	Min.
Total time occupied . . .	142	10	45
Average time per trip . .	10	23	..
Quickest trip by "Baltic" .	10	4	45
Longest trip by "Baltic" .	12	9	..

Cunard Line—14 trips, New York to Liverpool.

	Days.	Hrs.	Min.		Days.	Hrs.	Min.
Total time occupied . . .	160	18	44	.. ..	147	18	1
Average time per trip . .	11	11	..	.. ..	10	13	17
Quickest trip by "Africa" .	10	9	20	"Africa"	10	5	35
Longest trip by "Europa" .	14	3	..	"Canada"	12	21	20

The following are the names and voyages of the Cunard Steamers making the above averages:—

	Days.	Hrs.	Min.		Days.	Hrs.	Min.
Asia . .	13	14	30	Asia . .	10	15	11
Africa .	14	13	55	Africa .	10	17	28
Asia . .	13	1	40	Asia . .	10	6	40
Africa .	12	1	45	Africa .	10	8	50
Asia . .	10	23	25	Asia . .	10	6	..
Europa .	11	19	49	Europa .	10	19	37
Africa .	10	21	44	Africa .	10	17	35
Asia . .	10	21	15	Asia . .	10	2	47
Niagara .	12	22	..	Niagara .	10	21	50
Africa .	11	1	5	Africa .	10	4	30
Asia . .	11	..	15	Asia . .	10	20	28
Niagara .	12	9	13	Niagara .	10	20	40
Africa .	10	10	50	Africa .	10	5	35
				Asia . .	10	18	50
	155	17	26		147	18	1

Comparative Statement of average Sailings of Collins Line and Cunard Line for the first half of the Year 1852.

The following is extracted from 'Huntz's Merchant's Magazine,' September 1852:—

But the Cunard Company themselves give the following returns of the sailings of their steamers:—

Collins Line—13 trips, Liverpool to New York.

	Days.	Hrs.	Min.
Total time occupied . . .	154	20	15
Average time per trip . .	11	22	..
Quickest trip by "Atlantic"	10	3	..
Longest trip by "Pacific" .	15	4	30

Cunard Line—13 trips, Liverpool to New York.

	Days.	Hrs.	Min.		Days.	Hrs.	Min.
Total time occupied . . .	170	15	45	.. ..	163	12	18
Average time per trip . .	13	3	3	.. ..	12	13	52
Quickest trip by "Asia" .	10	19	..	"Asia" .	10	22	10
Longest trip by "Niagara".	20	19	..	"Canada"	17	22	30

Collins Line—13 trips, New York to Liverpool.

	Days.	Hrs.	Min.
Total time occupied . . .	148	17	50
Average time per trip . .	11	1	..
Quickest trip by "Arctic" .	9	13	30
Longest trip by "Baltic" .	12	21	..

Cunard Line—13 trips, New York to Liverpool.

	Days.	Hrs.	Min.		Days.	Hrs.	Min.
Total time occupied . . .	145	13	30	.. ..	141	18	32
Average time per trip . .	11	5	..	.. ..	10	21	44
Quickest trip by "Asia" .	10	5	10	"Asia" .	10	..	..
Longest trip by "Asia" .	12	21	30	"Asia" .	12	16	41

The following are the names and voyages of the Cunard steamers making the above averages:—

	Days	Hrs.	Min.		Days.	Hrs.	Min.
Asia . .	13	12	50	Asia . .	10	5	..
Canada .	17	22	30	Canada .	11	17	..
Africa .	14	..	40	Africa .	12	5	40
Asia . .	12	23	50	Asia . .	12	16	41
Europa .	12	4	11	Europa .	11	8	..
Africa .	11	10	45	Africa .	10	14	40
Asia . .	11	3	40	Asia . .	10	..	40
Europa .	12	9	26	Europa .	11	1	5
Africa .	11	23	30	Africa .	10	4	45
Asia . .	10	22	10	Asia . .	10	10	45
Europa .	11	8	20	Europa .	10	20	3
Africa .	11	15	16	Africa .	10	10	13
Asia . .	11	20	10	Asia . .	10	..	..
	163	12	18		141	18	32

APPENDIX No. 9. Vol. iv., p. 227.

"*Persia's*" *Passages* (*out and home*) *Liverpool and New York.*

Date.		Outward.	Homeward.	Detention at Queenstown, Bar, &c.	Consumption of Coal per Indicated H.P. per hour.
1856.		D. H. M.	D. H. M.		lbs.
Jan. 26	1	14 3 0	..	. . . .	3·47
Mar. 8	2	12 1 25	9 12 7		
Apr. 19	3	10 1 30	9 8 50		
July 12	4	10 19 13	9 4 35		
Aug. 23	5	10 22 7	9 18 37		
Oct. 4	6	10 2 32	9 7 2		
Nov. 15	7	10 3 0	9 11 20		
1857.					
Jan. 10	8	14 5 12	9 6 20		
Feb. 21	9	13 7 58	10 16 0		
June 13	10	9 21 41	9 2 55		
July 25	11	11 1 0	9 10 38		
Sept. 5	12	10 2 6	9 11 43		
Oct. 17	13	11 7 15	9 17 5		
Dec. 12	14	12 21 40	9 21 40		
1858.					
Mar. 20	15	10 19 56	9 17 15		
May 1	16	10 7 0	9 17 5		
June 5	17	10 16 0	9 6 28	. . . .	3·47
July 24	18	10 6 20	9 16 55		
For Newfoundland for "Europa" Passengers.					
Sept. 4	19	12 9 0	9 21 10		
Oct. 16	20	9 22 30	10 8 22		
Nov. 27	21	15 7 20	9 19 0		
1859.					
Mar. 19	22	11 4 30	10 17 20		
Apr. 30	23	11 4 47	9 7 40		
June 11	24	10 9 25	9 4 30		
July 23	25	10 21 50	9 16 45		
Sept. 3	26	15 18 10	9 17 2	3 Days—Broke crank-pin.	
Oct. 15	27	10 21 8	9 11 49		
Nov. 26	28	12 1 45	9 20 12		
1860.					
Mar. 31	29	11 17 45	9 19 12		
May 12	30	11 6 10	9 15 43		
June 23	31	12 6 18	9 8 45		

For Newfoundland for "Europa" Passengers.

Date.		Outward.	Homeward.	Detention at Queenstown, Bar, &c.	Consumption of Coal per Indicated H.P. per hour.
1860.		D. H. M.	D. H. M.		lbs.
Aug. 4	32	11 1 35	9 7 41		
Sept. 15	33	12 8 13	9 18 30		
Oct. 27	34	10 18 30	10 19 5		
Dec. 8	35	12 3 10	10 8 57	. . . .	3·47
1861.					
Mar. 30	36	10 1 30	9 17 50		
May 11	37	10 13 50	10 10 25		
June 22	38	11 1 0	9 18 5		
Aug. 3	39	11 1 30	10 12 27	Bell Buoy 12 hours.	
Sept. 14	40	10 22 0	10 19 47		
Oct. 26	41	10 3 13	11 16 17		
		Bic	Bic to Halifax	Halifax Home.	
Dec. 15	42	10 22 15	2 23 55	8 Days, 1 hour, 4 min.	
1862.					
Apr. 12	43	11 15 45	9 17 17	Queenstown 10 hrs. out.	
May 24	44	11 19 8	9 16 40		
July 5	45	11 2 25	9 19 33		
Aug. 16	46	11 3 5	10 4 35	Queenstown 6½ hrs. out.	
Sept. 27	47	12 8 53	9 13 28		
Nov. 8	48	12 14 5	13 13 55		
1863.					
Apr. 11	49	11 2 28	10 5 45		
May 23	50	10 23 45	9 22 30		
July 4	51	10 14 17	10 0 55		
Aug. 15	52	11 3 30	10 11 45	Queenstown. H. M. Out, 4 20. H. M. Home, 1 45.	
Sept. 26	53	11 5 5	10 10 5	,, 5 53. " "	
Nov. 7	54	11 19 40	9 22 2		
Dec. 19	55	11 22 44	10 5 40	Bar. H. M. Out, 3 0. H. M. Home, 4 0.	3·47
1864.					
Mar. 26	56	11 10 45	10 1 20	Out, 7 5.	
May 7	57	11 10 30	10 10 50	Queenstown. H. M. Out, 7 10. H. M. Home, 2 10.	
July 30	58	11 13 20	9 20 15		
Sept. 10	59	11 8 20	10 8 30	Bar. H. M. Out, 4 15. H. M. Home, 9 40.	

For Newfoundland for "Europa" Passengers.

Date.		Outward.	Homeward.	Detention at Queenstown, Bar, &c.		Consumption of Coal per Indicated H.P. per hour.
		D. H. M.	D. H. M.	Queenstown. H. M.	H. M.	lbs.
1864.						
Oct. 22	60	10 23 47	9 20 0	Out, 5 17.	Home, 1 0.	
1865.						
Apr. 8	61	11 10 15	10 4 45	,, 7 30.	,, 1 25.	
May 20	62	11 10 40	10 6 5	,, 3 10.	,, 1 30.	
July 1	63	11 1 0	10 5 8	,, 5 35.	,, 1 20.	
Aug. 12	64	11 0 30	9 21 10	,, 5 15.		
Sept. 23	65	10 18 45	9 22 0	,, 7 0.	,, 0 37.	
Nov. 4	66	10 23 0	11 0 40	,, 7 30.		
1866.						
Apr. 7	67	12 12 20	9 21 20	,, 6 17.		
May 19	68	10 11 55	9 15 55	,, 7 0.		3·47
June 30	69	12 3 35	9 20 20	,, 6 45.		
Aug. 11	70	11 4 10	9 18 20	,, 6 35.		
Sept. 22	71	13 11 55	9 20 15	,, 8 25.		
Nov. 3	72	10 23 35	9 21 55	,, 0 35.	,, 1 5.	
Dec. 29	73	13 0 55	10 5 0	,, 1 20.		
1867.						
Apr. 20	74	12 11 50	11 19 55	,, 5 15.		
June 1	75	11 21 35	10 4 25	,, 9 5.	,, 1 7.	
July 13	76	10 23 25	9 9 10	,, 0 55.	,, 0 20.	
Aug. 24	77	11 2 55	9 13 15	,, 2 30.		
Oct. 5	78	11 23 30	10 12 20	,, 4 5.		3·47
Nov. 16	79	10 4 25	11 19 0	,, 7 15.		
Dec. 28	80	13 7 10	10 17 25	,, 6 55.		

APPENDIX No. 10. Vol. iv., p. 237.

Account of Steamers belonging to the Cunard Company, in 1875.

(The vessels of this Company, which is a private undertaking, belong solely to Messrs. Burns, Glasgow, Messrs. MacIver, Liverpool, and Mr. William Cunard, London.)

Between Liverpool and United States.

		Year Built.	Gross.	Nett.	H.P.
1	Atlas	1860	2,393	1,552	300
2	Calabria	,,	2,901	1,730	409
3	Hecla	,,	2,421	1,578	270
4	Marathon	,,	2,403	1,552	300
5	Olympus	,,	2,415	1,585	270
6	Scotia	1862	3,871	2,124	1,000
7	China	,,	2,638	1,613	420
8	Cuba	1864	2,668	1,534	560
9	Aleppo	1865	2,056	1,398	280
10	Java	,,	2,696	1,760	600
11	Malta	,,	2,132	1,449	280
12	Tarifa	,,	2,058	1,399	280
13	Palmyra	1866	2,043	1,389	260
14	Russia	1867	2,960	1,709	600
15	Siberia	1868	2,497	1,698	300
16	Samaria	1870	2,605	1,694	300
17	Abyssinia	,,	3,253	2,075	500
18	Algeria	,,	3,298	2,104	500
19	Batavia	,,	2,553	1,627	450
20	Parthia	,,	3,166	2,035	450
21	Bothnia	,,	4,535	2,923	600
22	Scythia	1874	4,557	2,923	600
23	Saragossa	,,	2,262	1,429	300
24	Jackal } Tenders	1853	180	111	100
25	Satellite } Tenders	1848	157	82	80
			64,718	41,073	10,009

BETWEEN LIVERPOOL, HAVRE, AND THE MEDITERRANEAN.

		Year Built.	Gross.	Nett.	H.P.
1	Balbec	1853	774	484	130
2	British Queen	,,	763	565	150
3	Stromboli	1856	734	619	120
4	Kedar	1860	1,875	1,215	212
5	Sidon	1861	1,853	1,198	212
6	Morocco	,,	1,855	1,193	212
7	Trinidad	1872	1,899	1,228	300
8	Demerara	,,	1,904	1,231	300
9	Nantes	1873	1,472	949	160
10	Brest	1874	1,472	949	160
11	Cherbourg	,,	1,614	949	170
			16,215	10,580	2,126

HALIFAX AND BERMUDA TRADE.

		Year Built.	Gross.	Nett.	H.P.
1	Delta	1854	644	428	120
2	Alpha	1863	653	513	112
3	Beta	1874	1,087	677	160
			2,384	1,618	392

GLASGOW AND LIVERPOOL.

		Year Built.	Gross.	Nett.	H.P.
1	Penguin	1864	680	439	180
2	Raven	1869	778	490	150
3	Owl	1872	914	502	230
			2,372	1,431	560

Glasgow and Belfast.

		Year Built.	Gross.	Nett.	H.P.
1	Buffalo	1865	686	391	280
2	Llama	,,	686	391	280
3	Camel	1866	691	393	280
4	Racoon	1868	831	479	300
5	Hornet	1874	548	322	100
6	Wasp	,,	550	320	100
			3,992	2,296	1,340

Glasgow and Londonderry.

		Year Built.	Gross.	Nett.	H.P.
1	Bear	1870	691	331	150

Summary.

	Tonnage. Gross.	Tonnage. Nett.	Horse Power.
Transatlantic	64,718	41,073	10,009
Mediterranean and Havre	16,215	10,580	2,126
Halifax and Bermuda	2,384	1,618	392
Glasgow and Liverpool	2,372	1,431	560
,, Belfast	3,992	2,296	1,340
,, Londonderry	691	331	150
49 vessels	90,372	56,329	14,577

APPENDIX No. 12. Vol. iv., p. 244.

Rules for exercising Boats and Fire-Pumps, on board all Ships with eight Boats in the Cunard Service.

1st. Every officer in charge of a boat shall be conversant with the names and number of the crew thereof, and have a muster-roll of the same; and in exercising boats when mustered at "boats' stations," shall place his men, sailors forward, firemen amidships, stewards, &c., aft; and shall see that his men wear the badge with the number of the boat.

2nd. Each officer shall place two of sailing department, who will attend the outside chocks, gripes, and davit-lockings, lower the boat when swung out, and remain to belay the falls, when hoisted up. No boat to be lowered until the order is given, "lower away."

3rd. Each officer shall station two of sailing department to take cover off, and fore and aft spar out of the boat, and remain in her.

4th. In hoisting up, the crews of opposite boats assist each other, the starboard boat taking the after falls on both sides, and the port the forward.

Fire Stations.

In case of fire the crew of No. 8 boat shall attend to the port-hose, and No. 7 to the starboard: the crews of Nos. 5 and 6 working the main-deck pump, Nos. 3 and 4 the pump on the saloon, assisted by Nos. 1 and 2.

The steward department to attend the fire-buckets and blankets; a certain number to be told-off to each.

Bilge Pumps.

The crew of No. 8 boat shall rig and man the bilge pumps on port-side, forward, No. 7 taking the starboard forward, No. 6 the port amidships, No. 5 the starboard amidships, and No. 3 the starboard after-pump.

Water-tight Doors.

Carpenter to stand by to shut any water-tight doors which may be required, and all water-tight doors must always be kept in perfect order.

Every officer in the Cunard service is expected to know and act up to these rules.

Rules and Regulations of the Cunard Company (applicable to the Cabin).

It being obvious that, on a passage of some days' duration, the comfort of a numerous body of passengers must very much depend upon the manner in which they themselves assist in promoting it, a cheerful acquiescence is expected in the following regulations and suggestions, which, if in any instance at variance with the opinions, habits, or inclinations of the few, are framed with a regard to the comfort of the whole.

1.—In case of dissatisfaction with any of the servants, it is requested that the head steward may be informed, and, if the grievance be not immediately redressed, that the captain be appealed to, and, if of a serious nature, that it be represented in writing, in order that it may be brought before the agents at the conclusion of the voyage.

2.—The stewards and boys are engaged on the express understanding that at table they attend in becoming apparel.

3.—The state-rooms to be swept, and carpets to be taken out and shaken, every morning after breakfast. To be washed once a week, if the weather is dry.

4.—The saloon and ladies' cabins to be swept every morning before breakfast, beginning at 5 o'clock.

5.—Bedding to be turned over as soon as passengers quit their cabins. Slops to be emptied and basins cleaned at the same time. Beds to be made once a day only, except in cases of illness, &c., and within one hour after breakfast.

6.—Bed linen to be changed on the eighth day. Boots and shoes to be cleaned and put back into the state-rooms every morning at 8 o'clock.

7.—Two towels to be hung up for each passenger, and to be changed every other day, or as often as required.

8.—Passengers are requested not to open their scuttles when there is a chance of their bedding being wetted. The head steward to see that the scuttles are open when the weather will permit.

9.—The stewardess only is to enter the ladies' cabin and state-rooms, and to make the beds at the time before stated.

10.—The wine and spirit bar will be opened to passengers at 6 A.M., and closed at 11 P.M.

11.—Breakfast to be on the table at half-past 8, and cloths removed by half-past 9.

12.—Luncheon to be on table from 12 to 1 o'clock.

13.—The before-dinner bell to be rung at half-past 3—dinner to be on the table at 4—the cloths to be removed the instant it is over.

14.—Tea to be on the table at half-past 7.

15.—Supper, if required and ordered, to be before 10 o'clock.

16.—Lights to be put out in the saloons at half-past 11, and in the state-rooms at 12.

17.—As the labour of the servants must be very great, and the space required for a larger number absolutely preventing an increase, the passengers are requested to spare them as much as possible between the meal hours, and particularly preceding dinner.

18.—No passenger is allowed to change his state-room or berth without the knowledge of the purser; and it is understood that the passage tickets are to be given up to him before the termination of the voyage.

19.—With or without their owners, *dogs* are not allowed to come abaft the foremast.

APPENDIX No. 13. Vol. iv., p. 259.

Inman Company—Transatlantic Fleet, 1st Jan. 1875.

Number of Ships.	Names.	Year built	Gross Reg. Tonnage.	Nett Reg. Tonnage.	Horse Power.
1	Ajax	1856	163	133	30
2	Bosphorus	,,	448	333	30
3	Hercules	,,	211	174	30
4	City of Bristol	1860	2655	1,805	350
5	City of Limerick	1863	2536	1,724	250
6	City of London	,,	2765	1,880	450
7	City of Durham	1865	697	538	120
8	City of New York	,,	3,499	2,380	350
9	City of Paris	1866	3,081	1,975	550
10	City of Antwerp	1867	2,391	1,626	350
11	City of Brooklyn	1869	2,911	1,980	450
12	City of Brussels	,,	3,747	2,323	600
13	City of Montreal	1872	4,451	3,027	600
14	City of Chester	1873	4,700	3,000	800
15	City of Richmond	,,	4,700	3,000	800
16	City of Berlin	1874	5,000	3,500	1,000
	Total	. .	43,955	29,398	6,760

Abstract from the Log of the S.S. "City of Berlin," from Queenstown (Roche's Point) to New York (Sandy Hook).

7 Days, 18 Hours, 2 Minutes—Mean Time.

Date, September, 1875.		Wind.	Courses.	Distance run from Queenstown.	Latitude.	Longitude.	Remarks.
Thursday,	16	..	..	.	..	..	9.20 p.m. left Liverpool Bar.
Friday,	17	Southerly	Channel		N.	W.	11.30 a.m. arrived at Queenstown. 4.50 p.m. left Queenstown.
Saturday,	18	Variable	S. 81 W.	303	50·45	15·58	Calm.
Sunday,	19	Easterly	S. 79 W.	367	49·37	25·19	Light airs to light breeze.
Monday,	20	Easterly	S 77 W.	376	48·08	34·35	Light airs to light breeze.
Tuesday,	21	Easterly	S. 74 W.	368	46·18	43·11	Light airs to light breeze.
Wednesday,	22	N.E. to S.W.	S. 70 W.	380	43·59	51·34	Moderate breeze to calm.
Thursday,	23	Variable	S. 77 W.	374	42·37	59·49	Light variable airs.
Friday,	24	N.N.W.	S. 72 W.	381	50·52	67·55	Light to moderate breeze.
Saturday,	25	To Sandy Hook		280	..	..	6.30 a.m. arrived at Sandy Hook (New York).

Abstract from the Log of S.S. "City of Berlin"—Continued.

From New York (Sandy Hook) to Queenstown (Roche's Point).

7 Days, 15 Hours, 28 Minutes—Mean Time.

Date. October, 1875.		Wind.	Courses.	Distance run from Sandy Hook.	Latitude.	Longitude.	Remarks.
Saturday,	2	Westerly	..	..	N.	W.	9.0 a.m. passed Sandy Hook (New York). 9.15 discharged pilot. 9.20 ahead full speed.
Sunday,	3	Westerly	N. 80 E.	388	41·25	65·37	Light breeze.
Monday,	4	Variable	N. 74 E.	362	42·55	57·45	Calm to moderate breeze.
Tuesday.	5	S.W.	N. 70 E.	366	44·57	49·51	Light breeze throughout.
Wednesday,	6	S.W.	N. 68 E.	361	47·15	41·53	Light breeze throughout.
Thursday,	7	S.W. to N.W.	N. 71 E.	381	49·20	32·54	Fresh breeze throughout.
Friday,	8	North	N. 79 E.	347	50·23	24·06	Fresh gale and heavy beam sea.
Saturday,	9	North	N. 82 E.	362	51·17	14·43	Strong breeze and heavy beam sea.
Sunday,	10	To Queenstown		253	..	..	5.10 a.m. arrived at Queenstown; 6.10 left Queenstown; 5 p.m. Holyhead; 9.20 passed Rock Light, Liverpool.

APPENDIX No. 14. Vol. iv., p. 262.

Allan Line—Transatlantic Fleet, 1st Jan. 1875.

Names.	Gross Tonnage.	Nett Tonnage.	Horse-power Nominal.	Cabin accommodation for.
Sardinian	4,200	2,300	675	120
Polynesian	3,983	2,023	675	120
Sarmatian	3,911	2,175	650	100
Circassian	3,200	1,845	550	100
Scandinavian	2,840	1,811	500	100
Prussian	2,794	1,776	500	90
Austrian	2,458	1,650	450	115
Nestorian	2,466	1,677	455	115
Moravian	3,323	2,014	500	80
Peruvian	3,038	1,845	500	100
Hibernian	2,752	1,726	400	80
Nova Scotian	3,305	2,082	400	80
Caspian	2,728	1,788	400	80
Manitoban	2,395	1,543	300	25
Canadian	2,401	1,531	280	25
Corinthian	1,517	959	170	40
Phœnician	2,350	1,550	275	30
Waldensian	2,300	1,500	275	30
Acadian	931	596	100	..
Newfoundland	900	550	100	40
Rocket	350	175	100	..
Meteor	250	150	75	..
Mersey	227	51	20	..
	54,619	33,317	8,350	1,470

APPENDIX No. 15. Vol. iv., p. 276.

"White Star" Line of Steam Ships.

(Copy of Manuscript Letter of Special Instructions.)

CAPTAIN * * * * S.S. * * * *

Dear Sir,

In the Book of Instructions handed to you some time ago, and with the contents of which we do not doubt you have made yourself familiar, we dwelt with particular emphasis upon the supreme importance which we attached to the exercise of extreme and unvarying caution and prudence in the navigation of the Company's vessels. This subject has so constantly impressed itself upon us, that we have determined to address you again upon this most vital matter, and we shall be glad to know whether, in your opinion, and suggested by your experience of the steamers and their trade, there is any matter connected with their outfit, appointments or discipline, which you conceive might be supplemented or improved upon, in which case we shall gladly receive and consider any suggestions which you may make.

The consideration of the subject generally has impressed us with a deep sense of the injury which the interests of the Company would sustain in the event of any misfortune attending the navigation of the vessels:—First, from the blow which such would give to the reputation of the line; Second, from the pecuniary loss which would accrue—the Company being their own insurers to a very large extent; and, Third, to the interruption of a weekly line, upon which much of the success of the present organization must depend.

Under all these circumstances of paramount and engrossing interest to the Company, whose property is under your charge, we invite you to dismiss from your mind all idea of competitive passages with other vessels, the advantage of success in which is merely transient, concentrating your whole attention upon a *cautious*, *prudent*, and *ever-watchful* system of navigation—which shall lose time or suffer any other temporary inconvenience, rather than run the slightest risk which can be avoided.

We remain, yours faithfully,

ISMAY, IMRIE, & Co.

APPENDIX No. 16. Vol. iv., p. 279.

"WHITE STAR" LINE.

Abstract of Log.—Screw Steam-Ship "Adriatic," H. H. Perry, Commander. From Liverpool, viâ Queenstown, towards New York. Voyage No. 10.

Date, 1872.	No. of days out.	Barometer.	Thermometer. Dry.	Thermometer. Wet.							Distance run in Knots.	Remarks, &c.
April 3	2.50 p.m., weighed anchor. 3.18 p.m., Rock Light abeam. 4.0 p.m., off Bell Buoy.											
" 4	2.20 a.m., off Tuskar. 8.25 a.m., abreast Roche's Point. 8.40 a.m., anchored Queenstown Harbour. 10.20, received passengers. 0.30 p.m., weighed anchor and proceeded. 0.50 p.m., Roche's Point. 5.08 Fahr.											
" 5	1	S.	53	52	N. W.	5	C. B.	S. 85·37 W.	51·04 W.	16·00 W.	301	
" 6	2	S.	54	52	W.	8	C. B.	85·57	50·40	24·44	331	
" 7	3	F.	55	53	[illegible]	4	M. O.	84·00	50·01	33·54	355	
" 8	4	F.	47	53	S. W.	5	P. D.	78·17	48·58	41·40	309	
" 9	5	R.	32	34	N. W.	4	P. O.	65·36	46·46	48·52	318	
" 10	6	R.	31	34	N.	6	C. B.	61·05	43.38	56·57	396	
" 11	7	F. R.	43	[illegible]	Var.	4	R. B.	72·30	41·52	64·40	356	
" 12	8	F.	40	37	do.	4	M.	84·00	40·34	72·31	363	
	5.05 p.m., anchored off Bar.											
" 13	3.15 a.m., received pilot. 5.25 a.m., weighed anchor. 5.52 a.m., off Sandy Hook. 6.46., anchored, quarantine. 7.35 a.m., hove up anchor. 8.45 a.m., dock.											

(Signed) H. H. Perry, *Commander*.[1]

Explanation of Columns.

Barometer.—Letters—R., rising; F., falling; and S., steady. Extreme wind is the strongest wind experienced in past twenty-four hours.

Weather.—Beaufort scale is B., blue sky; C., detached clouds; D., drizzling rain; F., fog; G., dark, gloomy; H., hail; L., lightning; M., misty, hazy; O., overcast; P., passing showers; Q., squally; R., rain; S., snow; T., thunder; U., ugly, threatening; V. visibility; W. wet, dew.

[1] As will be seen by the above abstract of log, the *Adriatic* sailing *west*, made 396 knots, or 455 miles, in (calculating the actual time) 24½ hours, or equal to 18·55 miles per hour; but on her return passage on the same voyage (May 1872), she made (sailing *east*) 384 knots, or 441½ miles in 23½ hours actual time, which is equal to 18·9 miles per hour.

But however great the speed of the *Adriatic*, the *regularity* of the passages of this ship is equally surprising; they are as follows :—

FROM SANDY HOOK (NEW YORK) TO QUEENSTOWN.

		D. H. M.			D. H. M.
Voy. No. 1	April 1872	8 21 58	Voy. No. 15	October 1873	8 9 32
„ 2	June „	8 12 3	„ 16	November „	8 22 28
„ 3	August „	8 3 18	„ 17	December „	8 22 18
„ 4	Sept. „	8 19 26	„ 18	January 1874	8 6 18
„ 5	October „	8 7 54	„ 19	March „	8 13 23
„ 6	November „	8 8 18	„ 20	April „	8 6 28
„ 7	December „	8 23 38	„ 21	May „	8 4 56
„ 8	Feb. 1873	8 0 17	„ 22	June „	8 10 6
„ 9	March „	8 10 28	„ 23	July „	8 6 33
„ 10	April „	8 12 28	„ 24	October „	7 23 12
„ 11	May „	8 9 11	„ 25	January 1875	8 2 53
„ 12	June „	8 10 46	„ 26	February „	8 10 42
„ 13	August „	9 1 13	„ 27	April „	8 14 28
„ 14	Sept „	8 10 18	„ 28	May „	8 9 52
			„ 29	June „	8 3 12

Average—8 Days, 10 Hours, 57 Minutes.

But the *Adriatic* has been surpassed by the *Germanic*, whose last log is as follows :—

OUTWARDS.

Date.	Winds.	Courses.	Distances.	Latitude.	Longitude.	Weather.
1875.						
July 29	..	..	Left Liverpool 4.50 Bell Buoy, 6.42 p.m.			
„ 30	..	..	Left Queenstown 11·35 a.m. Roche's point abeam.			
		S. W.		North.	West	
„ 31	Northerly	87·34½	367	51·9	17·46	Fine.
Aug. 1	Variable	81·11	367	50·13	27·18	Overcast.
„ 2	Variable	77·00	360	48·52	36·19	Overcast, with head sea.
„ 3	Westerly	68·37	348	46·45	44·22	Cloudy, with head sea.
„ 4	N. Westerly	66·19	373	44·15	52·31	Fine.
„ 5	S. W.	72·52	364	42·29	60·29	Cloudy.
„ 6	S. W.	74·00	361	40·50	68·12	Cloudy.
„ 7	To S. Hook	..	260	..	..	Arrived off Sandy Hook. 6.20 a.m.

Mean Time—7 Days, 23 Hours, 7 Minutes.

Abstract of Log of S.S. "Germanic"—(continued.)

HOMEWARDS.

Date.	Wind.	Courses.	Distances.	Latitude.	Longitude.	Weather.
1875.						
Aug. 14	Left New York. Sandy Hook abeam 5.11 p.m.					
		N. E.		North.	West.	
" 15	Southerly.	87·33	278	40·40	68·20	Overcast.
" 16	Southerly.	69·00	343	42·24	61·12	Overcast.
" 17	Southerly.	65·33	341	44·45	54·4	Overcast.
" 18	Southerly.	65·23	341	47·7	46·39	Overcast.
" 19	S. W.	68·18	357	49·19	38·21	Overcast.
" 20	Westerly.	75·00	364	50·53	29·13	Moderate.
" 21	Westerly.	84·48	342	51·24	20·10	Fine.
" 22	S. W.	88·34	360	51·15	10·46	Fine.
	To Queenstown.		105		Arrived 7.41 p.m.	
" 23	In Channel Holyhead 8.22 a.m. Liverpool 1.20 p.m.					

Mean Time—7 Days, 22 Hours, 8 Minutes.

TABLE I.—OUTWARDS, 1873.—*Statement of Passages made to the Westward during 1873 by Steamers of the White Star, Cunard, Inman, National, and Guion Lines from Queenstown (2777 Miles), and of Bremen (N. German Lloyd's) Line from Southampton (2995 Miles), and of Hamburg-American Line from Havre to Sandy Hook (N.Y.).*

"WHITE STAR" LINE.					"CUNARD" LINE.				
Thursday Steamers.	SAILED.	MEAN TIME.			*Saturday Steamers.*	SAILED.	MEAN TIME.		
	Day. Mon. 1873.	D.	H.	M.		Day. Mon. 1873.	D.	H.	M.
Celtic	3 Jan.	11	12	27	Calabria	5 Jan.	11	11	55
Atlantic	10 ,,	11	22	2	Algeria	12 ,,	13	1	52
Adriatic	17 ,,	12	17	10	Cuba	19 ,,	*17	5	12
.. ..	..	..	..	..	Parthia	26 ,,	12	0	9
Baltic	31 ,,	10	7	27	Java	2 Feb.	10	20	31
Celtic	7 Feb.	8	11	2	Abyssinia	9 ,,	9	9	32
Atlantic	14 ,,	12	14	13	Algeria	16 ,,	10	17	27
Republic	21 ,,	10	8	9	Calabria	23 ,,	11	18	25
Adriatic	28 ,,	10	8	14	Parthia	2 Mar.	12	10	1
Baltic	7 Mar.	10	19	22	Cuba	9 ,,	11	0	54
Celtic	14 ,,	9	2	2	Abyssinia	16 ,,	9	14	2
.. ..	..	..	..		Algeria	23 ,,	11	18	25
.. ..	..	..	..		Russia	30 ,,	9	9	53
Adriatic	4 Apr.	8	8	37	Java	6 Apr.	9	5	10
Baltic	11 ,,	8	7	36	Cuba	13 ,,	9	6	37
Celtic	18 ,,	9	0	1	Scotia	20 ,,	9	17	8
Oceanic	25 ,,	9	12	46	Algeria	27 ,,	10	18	49
.. ..	..	..	..		Russia	4 May	10	3	56
Adriatic	9 May	8	17	41	Java	11 ,,	9	3	56
Baltic	16 ,,	8	21	15	Cuba	18 ,,	10	12	27
Celtic	23 ,,	9	13	17	Scotia	25 ,,	9	9	17
Oceanic	30 ,,	9	10	45	Algeria	1 June	9	10	5
.. ..	..	..	..		Russia	8 ,,	9	22	15
Adriatic	13 June	9	2	49	Java	15 ,,	9	20	43
Baltic	20 ,,	9	10	39	Cuba	22 ,,	10	8	20
Celtic	27 ,,	9	9	47	Scotia	29 ,,	9	17	12
Oceanic	4 July	10	1	18	Algeria	6 July	10	8	16
Gaelic	11 ,,	11	5	47	Russia	13 ,,	9	19	53
Adriatic	18 ,,	9	12	38	Java	20 ,,	9	15	58
Baltic	25 ,,	8	22	47	Cuba	27 ,,	9	22	39
Celtic	1 Aug.	9	9	32	Scotia	3 Aug.	9	18	43
Oceanic	8 ,,	10	8	14	Algeria	10 ,,	10	4	12
Republic	15 ,,	9	18	0	Russia	17 ,,	10	7	8
Adriatic	22 ,,	9	0	57	Java	24 ,,	9	17	55
Baltic	29 ,,	9	3	42	Cuba	31 ,,	9	12	24
Celtic	5 Sept.	8	14	22	Scotia	7 Sept.	9	17	40
Republic	12 ,,	9	15	52	Algeria	14 ,,	12	22	2
Gaelic	20 ,,	10	5	4	Russia	21 ,,	8	20	28
Adriatic	26 ,,	8	5	39	Java	28 ,,	8	22	32
Baltic	3 Oct.	8	17	24	Cuba	5 Oct.	11	4	10
Celtic	10 ,,	9	8	37	Scotia	12 ,,	10	5	47
Oceanic	17 ,,	9	10	46	Algeria	19 ,,	10	15	2
Republic	24 ,,	9	9	30	Russia	26 ,,	9	20	21
Adriatic	31 ,,	10	17	29	Java	2 Nov.	10	22	24
Baltic	7 Nov.	9	1	37	Cuba	9 ,,	11	7	34
Celtic	14 ,,	8	22	47	Abyssinia	16 ,,	11	0	57
Oceanic	21 ,,	10	22	22	Algeria	23 ,,	12	19	21
Republic	28 ,,	10	13	22	Russia	30 ,,	9	13	18
Adriatic	5 Dec.	9	14	53	Java	7 Dec.	11	20	28
Celtic	12 ,,	10	7	53	Cuba	14 ,,	11	20	26
Baltic	19 ,,	10	15	38	Calabria	21 ,,	14	5	42
Oceanic	26 ,,	11	23	22	Algeria	28 ,,	13	2	50
47 Sailings		461	18	53	52 Sailings		556	14	23
Average		9	19	48	Average		10	16	54

TABLE I.—OUTWARDS, 1873.—*Continued.*

"INMAN" LINE.					"GUION" LINE.				
Thursday Steamers.	SAILED.	MEAN TIME.			*Wednesday Steamers.*	SAILED.	MEAN TIME.		
	Day. Mon. 1873.	D.	H.	M.		Day. Mon. 1873.	D.	H.	M.
City of Brussels	3 Jan.	11	18	56	Idaho . .	2 Jan.	*16	6	52
,, Antwerp	10 ,,	15	1	42	Minnesota.	9 ,,	*17	22	30
,, London .	17 ,,	*16	14	12	Manhattan	16 ,,	*18	9	17
,, New York	24 ,,	14	4	22	Wisconsin.	23 ,,	12	14	42
,, Paris .	31 ,,	10	7	43	Nevada .	30 ,,	13	20	22
,, Montreal	7 Feb.	9	15	17	Wyoming .	6 Feb.	9	21	22
,, Brooklyn	14 ,,	11	20	20	Idaho . .	13 ,,	13	13	22
.. ..	..		..	..	Minnesota.	20 ,,	12	6	37
,, Antwerp	28 ,,	14	2	34	Manhattan	28 ,,	15	14	22
,, New York	8 Mar.	15	2	7	Wisconsin.	6 Mar.	12	10	22
,, Paris .	14 ,,	9	17	55	Nevada .	13 ,,	10	18	52
,, Montreal	21 ,,	12	8	17	Wyoming .	20 ,,	13	22	12
,, Brooklyn	28 ,,	10	5	16	Idaho . .	27 ,,	11	3	37
,, Antwerp	4 Apr.	10	12	7	Minnesota.	3 Apr.	11	20	47
,, London .	11 ,,	10	15	36	Manhattan	10 ,,	11	8	42
,, Paris .	18 ,,	9	14	51	Wisconsin.	17 ,,	10	4	2
,, Montreal	25 ,,	10	2	39	Nevada .	24 ,,	10	4	52
,, Brooklyn	2 May	10	16	42	Wyoming .	1 May	12	10	32
,, Antwerp	9 ,,	10	8	7	Idaho . .	8 ,,	10	12	32
,, London .	16 ,,	10	10	38	Minnesota.	15 ,,	11	21	42
,, Paris .	23 ,,	10	2	39	Manhattan	22 ,,	16	0	42
,, Montreal	30 ,,	10	3	27	Wisconsin.	29 ,,	9	20	37
,, Brooklyn	6 June	9	22	12	Nevada .	5 June	11	2	7
,, Antwerp	13 ,,	10	16	43	Wyoming .	12 ,,	10	21	52
,, Paris .	20 ,,	10	0	53	Idaho . .	19 ,,	11	10	7
,, London .	27 ,,	10	15	11	Minnesota.	26 ,,	12	1	5
,, Montreal	4 July	12	8	7	Wisconsin.	3 July	11	5	42
,, Chester .	11 ,,	9	6	7	Nevada .	11 ,,	11	17	52
,, Brooklyn	18 ,,	10	21	37	Manhattan	17 ,,	12	19	57
,, Paris .	25 ,,	9	3	57	Wyoming .	24 ,,	11	11	21
,, London .	1 Aug.	11	4	45	Idaho . .	31 ,,	11	11	48
,, Montreal	8 ,,	11	19	20	Minnesota.	7 Aug.	11	16	17
,, Chester .	15 ,,	9	4	11	Wisconsin.	14 ,,	10	12	12
,, Brussels	22 ,,	8	20	34	Nevada .	21 ,,	10	4	52
,, Paris .	29 ,,	9	18	7	Manhattan	28 ,,	12	22	50
,, Richmond	5 Sept.	9	6	52	Wyoming .	6 Sept.	13	4	22
,, Montreal	12 ,,	10	1	2	Idaho . .	13 ,,	12	12	2
,, Chester .	19 ,,	8	19	29	Minnesota.	18 ,,	11	3	47
,, Brussels	26 ,,	8	9	58	Wisconsin.	25 ,,	9	21	22
,, Paris .	3 Oct.	9	0	2	Nevada .	2 Oct.	10	18	22
,, Richmond	10 ,,	9	13	30	Manhattan	10 ,,	12	23	7
,, Montreal	17 ,,	10	7	2	Wyoming .	17 ,,	10	14	37
,, Chester .	24 ,,	8	17	48	Idaho . .	24 ,,	11	9	52
,, Brussels	31 ,,	10	12	51	Minnesota.	30 ,,	14	5	48
,, Paris .	7 Nov.	9	11	7	Wisconsin.	6 Nov.	10	13	34
,, Brooklyn	15 ,,	10	4	3	Nevada .	13 ,,	11	7	7
,, Montreal	21 ,,	*15	1	32	Manhattan	24 ,,	*15	4	2
.. ..	..		..	..	Wyoming	27 ,,	11	16	22
,, New York	5 Dec.	12	21	47	Idaho . .	4 Dec.	11	3	42
,, Chester .	12 ,,	10	0	1	Minnesota.	11 ,,	13	2	2
,, Antwerp	19 ,,	13	21	36	Wisconsin.	18 ,,	12	16	32
,, Brooklyn	26 ,,	12	11	21	Nevada .	25 ,,	13	14	22
50 Sailings .		515	23	12	52 Sailings .		638	9	1
Average . .		10	22	4	Average . .		12	6	38

Table I.—Outwards, 1873.—*Continued.*

"NATIONAL" LINE.					"BREMEN" LINE.				
Wednesday Sailings.	Sailed.	Mean Time.			*Tuesday Steamers.*	Sailed.	Mean Time.		
	Day. Mon. 1873.	D.	H.	M.		Day. Mon. 1873.	D.	H.	M.
Spain . .	4 Jan.	12	1	52	Mosel . .	7 Jan.	12	20	20
Italy . .	10 ,,	*15	2	37	America .	14 ,,	*22	22	50
Canada .	16 ,,	*18	10	22	Weser . .	21 ,,	13	4	35
Greece .	23 ,,	15	4	42	Bremen .	28 ,,	13	10	35
Egypt . .	30 ,,	11	14	47	Donau . .	5 Feb.	9	23	10
France. .	6 Feb	11	1	2	Main . .	11 ,,	13	18	50
Spain . .	15 ,,	12	7	7	Hansa . .	18 ,,	13	8	20
.. ..	..	..	..		Deutschland	25 ,,	13	16	50
Italy . .	27 ,,	14	18	52	Mosel . .	5 Mar.	11	2	50
Greece .	6 Mar.	14	18	22	Rhein . .	11 ,,	10	10	35
Egypt . .	14 ,,	11	8	2	Weser . .	18 ,,	10	18	50
Canada .	20 ,,	14	1	32	Donau . .	25 ,,	10	21	50
France. .	27 ,,	11	16	37	Main . .	1 Apr.	10	6	50
Spain . .	3 Apr.	10	2	52	Deutschland	8 ,,	9	18	20
Italy . .	10 ,,	11	3	37	Mosel . .	15 ,,	10	20	50
Greece. .	17 ,,	11	12	27	Rhein . .	22 ,,	9	17	50
Egypt . .	24 ,,	9	22	2	Weser . .	29 ,,	10	20	35
Canada .	1 May	11	21	22	Donau . .	5 May	10	12	50
Spain . .	8 ,,	9	11	32	Main . .	13 ,,	9	16	50
Italy . .	16 ,,	11	22	17	Deutschland	20 ,,	11	18	20
Greece. .	22 ,,	12	16	47	Hermann .	27 ,,	10	19	20
Egypt . .	30 ,,	9	14	12	Mosel . .	3 June	9	22	50
Canada .	5 June	10	21	22	Rhein . .	10 ,,	10	13	20
Spain . .	12 ,,	10	1	42	Donau . .	17 ,,	10	8	50
France .	19 ,,	12	8	57	Main . .	24 ,,	10	11	20
Greece. .	26 ,,	12	1	57	Deutschland	1 July	11	10	33
Egypt . .	3 July	10	19	47	Hermann .	8 ,,	11	12	50
Canada .	9 ,,	11	23	42	Mosel . .	15 ,,	10	17	50
Spain . .	17 ,,	10	6	7	Rhein . .	22 ,,	10	1	50
Italy . .	24 ,,	11	0	42	Weser . .	29 ,,	10	21	20
Greece. .	31 ,,	11	16	57	Main . .	5 Aug.	10	1	50
Egypt . .	7 Aug.	10	3	32	Deutschland	12 ,,	10	17	50
Canada .	14 ,,	11	14	57	Hermann .	19 ,,	11	14	35
Spain . .	21 ,,	9	19	7	Mosel . .	26 ,,	10	0	20
Italy . .	28 ,,	11	3	49	Rhein . .	2 Sept.	9	16	20
France .	4 Sept.	11	11	2	Weser . .	9 ,,	10	13	50
Egypt . .	11 ,,	10	10	32	Main . .	16 ,,	10	6	5
Greece. .	18 ,,	10	16	27	Deutschland	23 ,,	10	1	50
Spain . .	25 ,,	9	1	17	Donau . .	30 ,,	9	16	50
Italy . .	2 Oct.	10	5	22	Mosel . .	7 Oct.	11	18	50
France. .	11 ,,	12	21	7	Rhein . .	14 ,,	9	20	50
Egypt . ..	16 ,,	9	21	57	Weser . .	21 ,,	11	4	50
Greece. .	24 ,,	11	9	37	Hansa . .	28 ,,	14	21	20
Spain . .	30 ,,	12	17	1	Main . .	4 Nov.	10	17	50
Italy . .	6 Nov.	10	2	22	Deutschland	8 ,,	10	8	50
France .	16 ,,	14	0	2	Donau . .	18 ,,	11	7	50
Egypt . .	20 ,,	14	13	17	Mosel . .	26 ,,	12	6	50
Greece. .	27 ,,	13	5	22	Hermann .	2 Dec.	10	19	0
.. ..	..	..	..		Rhein . .	9 ,,	10	19	50
Italy . .	11 Dec.	12	18	2	Weser . .	16 ,,	11	19	50
Spain . .	18 ,,	12	12	22	New York.	23 ,,	15	13	50
Canada .	25 ,,	*14	18	32	Main . .	30 ,,	12	2	50
50 Sailings .		595	8	21	52 Sailings .		593	20	43
Average . .		11	21	36	Average . .		11	10	5

TABLE I.—OUTWARDS, 1873.—*Continued.*

"HAMBURG" LINE.

Saturday Steamers.	Sailed. Day. Mon. 1873.	Mean Time. D.	H.	M.
Silesia . .	4 Jan.	12	·17	26
Frisia . .	11 ,,	13	9	56
Westphalia	18 ,,	*15	·15	56
Thuringia .	25 ,,	12	17	56
Hammonia	1 Feb.	11	·19	56
Cimbria .	9 ,,	10	·10	56
Silesia . .	15 ,,	11	·13	56
Frisia . .	22 ,,	12	6	26
Westphalia	1 Mar.	12	·16	51
Thuringia .	8 ,,	11	·14	56
Hammonia	15 ,,	11	· 8	26
.. ..	..	..	..	..
Silesia . .	29 ,,	10	· 9	56
Frisia . .	5 Apr.	10	0	56
Westphalia	12 ,,	10	· 0	56
Thuringia .	19 ,,	10	·14	41
Hammonia	27 ,,	10	·10	0
Holsatia .	3 May	11	· 8	11
Silesia . .	10 ,,	·9	·22	39
Frisia . .	17 ,,	11	5	54
Westphalia	24 ,,	10	21	14
Thuringia .	31 ,,	10	· 1	39
Cimbria .	7 June	11	·14	39
Hammonia	14 ,,	11	· 1	41
Holsatia .	21 ,,	10	· 7	56
Silesia . .	28 ,,	11	2	56
Frisia . .	6 July	10	2	26
Westphalia	12 ,,	11	0	26
Thuringia .	19 ,,	10	·21	56
Cimbria .	26 ,,	10	23	56
Hammonia	2 Aug.	12	·13	26
Holsatia .	10 ,,	10	18	56
Silesia . .	16 ,,	12	1	56
Frisia . .	23 ,,	10	·22	50
Westphalia	30 ,,	10	·16	20
Thuringia .	6 Sept	10	·22	30
Cimbria .	13 ,,	12	· 2	20
Holsatia .	20 ,,	10	15	50
Silesia . .	27 ,,	10	·10	50
Frisia . .	4 Oct.	12	· 2	50
Westphalia	11 ,,	11	· 2	56
Thuringia .	18 ,,	10	·18	35
Cimbria .	26 ,,	10	14	50
Holsatia .	2 Nov.	10	·20	50
Silesia . .	8 ,,	10	20	20
Frisia . .	15 ,,	10	8	20
Westphalia	23 ,,	12	18	20
Thuring'a .	30 Nov.	10	8	50
Pomerania	6 Dec.	11	·13	56
Holsatia .	14 ,,	11	19	26
Cimbria .	20 ,,	13	8	56
Hammonia	27 ,,	14	0	56
51 Sailings .		580	3	46
Average . .		11	9	1

Line.	Over 8 and under 8½ days.	Over 8½ and under 9 days.	Over 9 and under 9½ days.	Over 9½ and under 10 days.	Over 10 and under 10½ days.	Over 10½ and under 11 days.	Over 11 and under 11½ days.	Over 11½ and under 12 days	Over 12 and under 13 days.	Over 13 and under 14 days.	Over 14 and under 15 days.	Over 15 and under 16 days.	Over 16 and under 17 days.	Over 17 and under 18 days.	Over 18 and under 19 days.	Over 19 and under 20 days.	Over 20 and under 21 days.	Over 21 and under 22 days.	Over 22 and under 23 days.	No. of Sailings in 1873.	Duration. D. H. M.	Average. D. H. M.
White Star Line	4	6	13	6	7	5	1	3	2	..	..	..	..	..	..	..	..	..	..	47	461 19 53	9 19 48
Cunard . . .	..	2	7	14	6	6	5	4	4	2	1	..	..	1	..	..	..	..	..	52	556 14 23	10 16 54
Inman . . .	1	3	6	6	12	7	1	3	4	1	2	3	1	..	..	..	..	..	..	50	545 23 12	10 22 4
National . .	..	..	2	4	7	3	7	8	9	1	6	2	..	..	1	..	..	..	..	50	595 8 21	11 21 36
Guion . . .	..	..	..	3	3	7	11	5	10	6	1	2	2	1	1	..	..	..	..	52	638 9 1	12 6 38
Bremen . .	..	..	..	8	10	14	4	5	3	5	1	1	..	..	..	..	..	..	1	52	593 20 43	11 10 5
Hamburg . .	..	..	..	1	11	13	7	6	9	2	1	1	..	..	..	..	..	..	..	51	580 3 46	11 9 1

TABLE II.—OUTWARDS, 1874. *Statement of Passages made to the Westward during 1874 by Steamers of the White Star, Cunard, Inman, National, and Guion Lines, from Queenstown (2775 Miles), and of Bremen (N. German Lloyd's) Line from Southampton (2995 Miles), and of Hamburg-American Line from Havre to Sandy Hook (N.Y.)*

"WHITE STAR" LINE.					"CUNARD" LINE.				
Thursday Steamers.	SAILED.	MEAN TIME.			*Saturday Steamers.*	SAILED.	MEAN TIME.		
	Day. Mon. 1874.	D.	H.	M.		Day. Mon. 1874.	D.	H.	M.
Republic .	2 Jan.	10	13	11	Russia .	4 Jan.	10	3	56
Adriatic .	9 ,,	9	17	32	Java . .	11 ,,	11	23	56
Gaelic . .	16 ,,	12	4	42	Abyssinia .	18 ,,	11	6	20
Baltic . .	23 ,,	9	10	12	Calabria .	25 ,,	10	19	27
Oceanic .	30 ,,	11	10	11	Algeria .	1 Feb.	11	15	7
Republic .	6 Feb.	11	4	20	Russia . .	8 ,,	11	12	44
Celtic . .	13 ,,	10	12	22	Cuba . .	15 ,,	11	15	50
Adriatic .	20 ,,	10	19	37	Abyssinia .	22 ,,	12	20	22
Baltic . .	27 ,,	9	9	52	Calabria .	1 Mar.	10	3	55
Oceanic .	6 Mar.	10	8	6	Algeria .	8 ,,	10	2	26
Republic .	13 ,,	10	8	7	Java . .	15 ,,	12	8	44
Celtic . .	20 ,,	11	8	30	Cuba . .	22 ,,	11	18	37
Adriatic .	27 ,,	12	5	39	Abyssinia .	29 ,,	14	1	17
Baltic . .	3 Apr.	11	3	27	Russia . .	5 Apr.	11	9	50
Oceanic .	10 ,,	11	16	13	Calabria .	12 ,,	12	13	12
Republic .	17 ,,	11	0	27	Scotia . .	19 ,,	10	15	43
Celtic . .	24 ,,	9	22	38	Cuba . .	26 ,,	10	14	42
Adriatic .	1 May	8	18	4	Abyssinia .	3 May	9	15	42
Baltic . .	8 ,,	10	7	59	Russia . .	10 ,,	10	7	52
Oceanic .	15 ,,	9	7	2	Calabria .	17 ,,	9	16	35
Republic .	22 ,,	8	18	45	Scotia . .	24 ,,	9	10	40
Celtic . .	29 ,,	9	6	50	Cuba . .	31 ,,	10	8	33
Adriatic .	5 June	8	19	13	Abyssinia .	7 June	10	5	17
.. ..	..	..	..	..	Russia . .	14 ,,	8	22	35
Oceanic .	19 ,,	10	1	2	Calabria .	21 ,,	10	5	36
Britannic .	26 ,,	8	1	58	Scotia . .	28 ,,	9	5	59
Celtic . .	3 July	9	4	23	Cuba . .	5 July	10	6	35
Adriatic .	10 ,,	9	2	2	Abyssinia .	12 ,,	9	19	5
Republic	17 ,,	8	20	55	Russia . .	19 ,,	9	8	17
Baltic . .	24 ,,	8	22	39	Calabria .	26 ,,	10	18	15
Britannic .	31 ,,	10	13	35	Scotia . .	2 Aug.	10	5	32
Celtic . .	7 Aug.	9	1	1	Bothnia .	9 ,,	10	7	55
Oceanic .	14 ,,	9	10	43	Abyssinia .	16 ,,	9	9	29
Republic .	21 ,,	9	1	51	Russia . .	23 ,,	9	2	5
Baltic . .	28 ,,	9	1	42	Cuba . .	30 ,,	10	19	22
Britannic .	4 Sept.	9	21	7	Scotia . .	6 Sept.	9	22	42
Celtic . .	11 ,,	8	20	17	Algeria .	13 ,,	9	4	2
Oceanic .	18 ,,	9	6	47	Abyssinia .	20 ,,	9	11	47
Republic .	25 ,,	10	0	44	Russia . .	27 ,,	9	18	5
Baltic . .	2 Oct.	9	14	17	Bothnia .	4 Oct.	11	3	55
Adriatic .	9 ,,	9	1	0	Cuba . .	11 ,,	11	19	32
Celtic . .	16 ,,	9	22	49	Algeria .	18 ,,	10	19	26
Oceanic .	23 ,,	9	22	27	Abyssinia .	25 ,,	10	1	2
Republic .	30 ,,	9	8	25	Russia . .	1 Nov.	10	1	22
Baltic . .	6 Nov.	8	23	39	Java . .	8 ,,	9	10	30
.. ..	..	..	..	..	Parthia .	15 ,,	12	1	7
Celtic . .	20 ,,	9	21	21	Algeria .	22 ,,	11	7	51
Oceanic .	27 ,,	10	1	57	Abyssinia .	29 ,,	10	4	27
Republic .	4 Dec.	9	19	27	Russia . .	6 Dec.	11	10	22
Baltic . .	12 ,,	9	3	2	Java . .	13 ,,	9	21	17
Adriatic .	18 ,,	9	16	7	Cuba . .	20 ,,	12	21	42
Gaelic . .	24 ,,	*14	6	22	Algeria .	27 ,,	12	22	8
50 Sailings .		497	16	38	52 Sailings .		556	2	29
Average . .		9	22	53	Average . .		10	16	40

TABLE II.—OUTWARDS, 1874.—*Continued.*

"INMAN" LINE.

Thursday Steamers.	Sailed. Day. Mon. 1874.	Mean Time. D.	H.	M.
City of Brussels .	2 Jan.	10	15	38
,, Montreal.	9 ,,	12	20	22
,, Chester .	16 ,,	10	3	21
,, New York	23 ,,	12	5	2
,, Antwerp .	30 ,,	*14	8	53
,, Brooklyn	6 Feb.	12	12	12
,, Brussels .	13 ,,	10	23	32
,, Montreal.	20 ,,	14	18	47
,, Baltimore	27 ,,	11	2	57
,, Richmond	6 Mar.	9	8	7
,, Brooklyn	13 ,,	12	15	22
,, Brussels .	20 ,,	11	14	51
,, Paris . .	27 ,,	12	14	52
,, Montreal.	4 Apr.	14	7	42
,, Richmond	10 ,,	9	5	24
,, Brooklyn	17 ,,	11	19	25
,, Brussels .	24 ,,	10	16	38
,, Chester .	1 May	8	9	32
,, Richmond	8 ,,	9	19	42
,, Paris . .	15 ,,	9	4	52
,, Brooklyn	22 ,,	9	18	26
,, Brussels .	29 ,,	10	2	56
,, Chester .	5 June	8	13	37
,, Richmond	12 ,,	8	14	34
,, Paris . .	19 ,,	9	11	17
,, Montreal.	26 ,,	10	7	42
,, Brooklyn	3 July	11	3	8
,, Chester .	10 ,,	8	15	9
,, Richmond	17 ,,	8	11	12
,, Paris . .	24 ,,	9	22	47
,, Montreal	31 ,,	10	19	12
,, Brussels .	7 Aug.	9	11	51
,, Chester .	14 ,,	8	17	22
,, Richmond	21 ,,	8	14	13
,, Paris . .	28 ,,	10	16	37
,, Montreal.	4 Sept.	10	17	17
,, Brussels .	11 ,,	9	0	40
,, Chester .	18 ,,	8	16	52
,, Richmond	25 ,,	9	0	39
,, Paris . .	2 Oct.	10	20	22
,, Montreal.	9 ,,	11	21	42
,, Antwerp .	16 ,,	13	0	14
,, Brooklyn	23 ,,	10	10	40
,, New York	30 ,,	11	18	46
,, London .	6 Nov.	11	20	50
,, Montreal	13 ,,	12	3	47
,, Antwerp .	20 ,,	12	2	49
,, Brooklyn	27 ,,	10	9	42
,, New York	4 Dec.	13	13	2
.. .. ..	..		..	..
,, Montreal.	18 ,,	13	13	12
,, Antwerp .	25 ,,	*15	6	17
51 Sailings .		556	19	0
Average . .		10	22	1

"NATIONAL" LINE.

Wednesday Steamers.	Sailed. Day. Mon. 1874.	Mean Time. D.	H.	M.
Egypt . .	2 Jan.	12	2	52
Greece .	8 ,,	12	15	22
Italy . .	15 ,,	13	15	12
Spain . .	22 ,,	10	14	12
Canada .	29 ,,	14	22	42
Egypt . .	5 Feb.	11	16	12
Greece. .	13 ,,	15	8	32
Italy . .	20 ,,	14	10	52
Spain . .	26 ,,	11	11	2
Canada .	8 Mar.	12	8	22
Egypt . .	12 ,,	11	8	52
.. ..	..		..	..
Greece. .	26 ,,	18	6	32
Italy . .	3 Apr.	14	10	17
Spain . .	9 ,,	11	4	7
Egypt . .	16 ,,	12	22	12
The Queen	23 ,,	11	12	7
Canada .	30 ,,	11	1	57
.. ..	..		..	..
Spain . .	14 May	10	8	22
Greece. .	21 ,,	11	12	52
Egypt . .	28 ,,	11	5	28
The Queen	4 June	10	17	57
Italy . .	11 ,,	10	22	47
Spain . .	19 ,,	11	6	32
.. ..	..		..	..
Greece. .	2 July	13	16	7
Egypt . .	9 ,,	10	9	27
The Queen	16 ,,	9	20	42
Italy . .	23 ,,	11	22	22
Spain . .	30 ,,	10	23	57
Canada .	6 Aug.	12	22	7
Egypt . .	13 ,,	10	6	22
The Queen	20 ,,	10	7	22
England .	27 ,,	11	14	52
Spain . .	3 Sept.	11	8	42
Erin . .	10 ,,	10	22	47
Egypt . .	17 ,,	10	3	7
The Queen	25 ,,	11	2	51
.. ..	..		..	..
England .	10 Oct.	12	5	22
Spain . .	15 ,,	11	6	57
Erin . .	25 ,,	10	18	22
Egypt . .	29 ,,	10	8	37
.. ..	..		..	..
England .	14 Nov.	13	17	2
Spain . .	19 ,,	12	4	12
Helvetia .	26 ,,	12	2	32
Erin . .	3 Dec.	14	1	17
Italy . .	12 ,,	13	13	22
The Queen	17 ,,	13	5	52
Denmark .	24 ,,	*19	16	37
47 Sailings .		574	18	19
Average . .		12	5	30

TABLE II.—OUTWARDS, 1874.—*Continued.*

"GUION" LINE.

Wednesday Steamers.	Sailed. Day. Mon. 1874.	Mean Time. D.	H.	M.
Wyoming .	3 Jan.	11	18	22
Idaho . .	9 ,,	12	1	22
Manhattan	15 ,,	14	15	37
Minnesota.	22 ,,	12	1	22
Wisconsin.	29 ,,	11	14	47
Nevada .	5 Feb.	13	11	22
.. ..	..	..	..	..
Idaho . .	19 ,,	*14	8	22
Manhattan	27 ,,	13	22	52
Minnesota.	6 Mar.	13	0	2
Wyoming .	12 ,,	11	3	37
Nevada .	19 ,,	14	17	42
.. ..	..	..	..	
Idaho . .	3 Apr.	*14	3	4
Wisconsin .	10 ,,	11	6	17
Minnesota.	16 ,,	13	20	37
Wyoming .	23 ,,	11	11	52
.. ..	..	..	..	
Nevada .	7 May	13	15	52
Idaho . .	14 ,,	11	8	22
Wisconsin .	21 ,,	10	5	2
Minnesota.	28 ,,	12	15	12
Wyoming .	4 June	10	17	22
Nevada .	12 ,,	9	20	52
.. ..	..	..	..	
Idaho . .	25 ,,	10	17	42
Wisconsin.	2 July	*15	7	42
Minnesota.	9 ,,	11	15	2
Wyoming .	16 ,,	9	17	32
.. ..	..	..	..	
Nevada .	30 ,,	11	15	52
Idaho . .	6 Aug.	11	9	45
Wisconsin.	13 ,,	10	12	32
Minnesota.	20 ,,	11	2	45
.. ..	..	..	..	
Wyoming .	3 Sept.	10	20	32
Nevada .	10 ,,	10	12	17
Idaho . .	17 ,,	10	16	12
Wisconsin.	25 ,,	10	14	42
Minnesota.	1 Oct.	13	21	22
.. ..	..	.	..	
Wyoming .	15 ,,	11	5	2
Nevada .	23 ,,	10	22	22
.. ..	..	..	..	
Wisconsin.	5 Nov.	10	21	2
.. ..	..	..	..	
Minnesota.	19 ,,	13	18	7
.. ..	..	..	..	
Wyoming .	3 Dec.	12	3	10
.. ..	..	..	..	
Wisconsin .	17 ,,	13	6	7
Idaho . .	24 ,,	*15	3	22
41 Sailings .		497	23	8
Average . .		12	3	29

"BREMEN" LINE.

Tuesday Steamers.	Sailed. Day. Mon. 1874.	Mean Time. D.	H.	M.
Donau . .	6 Jan.	10	19	50
Mosel . .	13 ,,	11	17	50
Hermann .	20 ,,	12	6	5
Hansa . .	27 ,,	13	13	50
Weser . .	3 Feb.	11	23	5
Rhein . .	10 ,,	11	11	50
Main . . .	17 ,,	12	18	50
Donau . .	24 ,,	12	9	50
Mosel . .	3 Mar.	10	17	50
America . .	10 ,,	11	3	50
Hansa . .	17 ,,	15	10	5
Weser . .	24 ,,	11	21	20
Rhein . .	31 ,,	13	1	35
Main . . .	7 Apr.	11	13	50
Donau . .	14 ,,	12	9	35
Neckar . .	21 ,,	11	15	25
Mosel. . .	28 ,,	10	10	40
Weser . .	5 May	11	2	20
Rhein . .	12 ,,	10	14	50
Main . . .	19 ,,	9	20	50
Oder . . .	26 ,,	12	4	20
Neckar . .	2 June	10	8	50
Mosel . .	9 ,,	9	20	50
America . .	16 ,,	10	22	50
Rhein . .	23 ,,	10	7	45
Main . . .	1 July	10	18	40
Oder . . .	7 ,,	11	7	50
Neckar . .	14 ,,	10	2	10
Mosel. . .	21 ,,	10	9	36
America . .	28 ,,	12	0	50
Deutschland.	4 Aug.	11	3	45
Weser . .	11 ,,	10	19	35
Main . . .	18 ,,	9	14	20
Neckar . .	25 ,,	10	16	5
Donau . .	1 Sept.	10	13	50
Mosel. . .	8 ,,	11	0	20
Hermann .	15 ,,	11	8	20
Rhein . .	23 ,,	9	19	20
Main . . .	29 ,,	9	22	50
Oder . . .	6 Oct.	11	0	50
Neckar . .	13 ,,	11	4	0
Donau . .	20 ,,	10	19	10
Hohenstaufen	27 ,,	12	11	30
America . .	3 Nov.	11	18	55
Hermann .	10 ,,	11	12	20
Deutschland.	17 ,,	11	20	45
Hansa . .	24 ,,	14	17	5
Oder . . .	1 Dec.	10	6	20
Neckar . .	9 ,,	12	0	20
Hohenzollern	15 ,,	12	20	50
Hohenstaufen	23 ,,	*15	19	55
America . .	29 ,,	13	18	50
52 Sailings . .		600	3	16
Average . . .		11	13	0

TABLE II.—OUTWARDS, 1874.—*Continued.*

"HAMBURG" LINE.

Saturday Steamers.	Sailed. Day. Mon. 1873.	Mean Time. D.	H.	M.
Silesia . .	3 Jan.	11	13	16
Frisia . .	10 ,,	11	3	56
Westphalia	17 ,,	12	12	36
Thuringia .	24 ,,	10	16	56
Pomerania	31 ,,	11	1	56
Holsatia .	7 Feb.	11	22	56
Hammonia	*14 ,,	14	6	56
.. ..	..	...	..	..
Frisia . .	28 ,,	11	3	56
Thuringia .	7 Mar.	10	9	56
Westphalia	14 ,,	11	16	56
Silesia . .	21 ,,	12	12	56
Holsatia .	28 ,,	13	5	50
Hammonia	4 Apr.	12	11	56
Frisia . .	11 ,,	12	3	56
Thuringia .	18 ,,	11	17	26
Westphalia	25 ,,	11	3	56
Pomerania	2 May	10	8	56
Holsatia .	9 ,,	11	7	56
Silesia . .	16 ,,	10	3	56
Frisia . .	23 ,,	11	2	56
Thuringia .	30 ,,	11	7	56
Westphalia	6 June	11	3	56
Pomerania	13 ,,	10	9	55
Holsatia .	20 ,,	11	3	56
Silesia . .	27 ,,	11	5	56
Hammonia	4 July	12	7	56
Frisia . .	12 ,,	10	0	56
Thuringia .	18 ,,	10	13	56
Westphalia	25 ,,	11	7	36
Pomerania .	1 Aug.	11	2	56
Holsatia .	8 ,,	11	4	56
Cimbria .	15 ,,	12	0	0
Hammonia	22 ,,	11	0	26
Frisia . .	29 ,,	11	1	56
Thuringia .	5 Sept.	10	22	56
Pomerania	12 ,,	10	4	41
Silesia . .	19 ,,	9	21	56
Holsatia .	26 ,,	10	18	26
Cimbria .	3 Oct.	12	2	21
Frisia . .	10 ,,	11	19	56
Thuringia .	17 ,,	11	12	56
Suevia . .	25 ,,	11	15	56
Westphalia	1 Nov.	12	8	56
Pomerania	7 ,,	10	2	56
Silesia . .	14 ,,	11	17	56
Holsatia .	21 ,,	11	0	0
Cimbria .	30 ,,	11	11	56
Frisia . .	5 Dec.	12	5	11
Westphalia	12 ,,	11	14	56
Suevia . .	19 ,,	*15	20	56
Pomerania	26 ,,	12	3	56
51 Sailings ,		586	11	13
Average . .		11	12	0

Line.	Over 8 and under 8½ days.	Over 8½ and under 9 days.	Over 9 and under 9½ days.	Over 9½ and under 10 days.	Over 10 and under 10½ days.	Over 10½ and under 11 days.	Over 11 and under 11½ days.	Over 11½ and under 12 days.	Over 12 and under 13 days.	Over 13 and under 14 days.	Over 14 and under 15 days.	Over 15 and under 16 days.	Over 16 and under 17 days.	Over 17 and under 18 days.	Over 18 and under 19 days.	Over 19 and under 20 days.	No. of Sailings in 1874.	Duration. D.	H.	M.	Average. D.	H.	M.
White Star Line .	1	7	14	9	6	4	5	1	2	..	1	..	..	..	..	..	50	497	16	38	9	22	53
Cunard Line . .	..	1	8	6	13	6	5	6	6	..	1	..	..	..	..	..	52	556	2	29	10	16	40
Inman Line . .	2	6	7	3	5	7	2	5	7	3	3	1	..	..	..	..	51	556	19	0	10	22	1
National Line	..	..	..	1	6	6	9	5	8	5	4	1	..	..	1	1	47	574	18	19	12	5	30
Guion Line . .	..	..	..	2	1	9	7	4	4	8	4	2	..	..	..	..	41	497	23	8	12	3	29
Bremen Line . .	..	..	..	5	6	9	9	8	9	3	1	2	..	..	..	..	52	600	3	16	11	13	0
Hamburg Line	..	..	..	1	7	4	17	9	10	1	1	1	..	..	..	..	51	586	11	13	11	12	0

TABLE III.—HOMEWARDS, 1873.—*Statement of Passages made to the Eastward during 1873 by Steamers of the White Star, Cunard, Inman, National, and Guion Lines, to Queenstown (2777 Miles), and of Bremen (N. German Lloyd's Line to Southampton (2995 Miles), and of Hamburg-American Line to Plymouth, all from Sandy Hook (N.Y.).*

"WHITE STAR" LINE.

Saturday Steamers.	SAILED. Day. Mon. 1873.	MEAN TIME. D.	H.	M.
Oceanic	4 Jan.	10	14	47
.. ..	..	..	..	..
Baltic	11 ,,	7	20	9
Celtic	19 ,,	8	17	38
Atlantic	25 ,,	9	10	44
.. ..	..	..	..	..
Adriatic	8 Feb.	8	0	17
Baltic	16 ,,	9	3	38
Celtic	23 ,,	9	0	13
Atlantic	2 Mar.	9	8	33
Republic	8 ,,	9	3	7
Adriatic	15 ,,	8	10	28
Baltic	22 ,,	8	5	21
Celtic	29 ,,	8	22	28
.. ..	..	..	..	..
.. ..	..	..	..	..
Adriatic	19 Apr.	8	12	28
Baltic	26 ,,	8	13	3
Celtic	3 May	9	5	33
Oceanic	12 ,,	9	0	58
.. ..	..	..	..	..
Adriatic	24 ,,	8	9	11
Baltic	31 ,,	8	12	42
Celtic	7 June	8	18	36
Oceanic	14 ,,	8	23	34
.. ..	..	..	..	..
Adriatic	28 ,,	8	10	46
Baltic	5 July	8	15	10
Celtic	12 ,,	8	17	18
Oceanic	19 ,,	9	10	48
Gaelic	26 ,,	9	19	38
Adriatic	2 Aug.	9	1	13
Baltic	9 ,,	8	11	11
Celtic	16 ,,	9	2	30
Oceanic	23 ,,	10	0	42
Republic	30 ,,	8	15	49
Adriatic	6 Sept.	8	10	18
Baltic	13 ,,	8	12	28
Celtic	20 ,,	10	0	40
Republic	27 ,,	8	23	45
Gaelic	4 Oct.	10	15	58
Adriatic	11 ,,	8	9	32
Baltic	18 ,,	8	19	56
Celtic	25 ,,	8	15	58
Oceanic	1 Nov.	9	4	53
Republic	8 ,,	9	7	48
Adriatic	15 ,,	8	22	28
Baltic	22 ,,	8	18	38
Celtic	29 ,,	8	18	41
Oceanic	6 Dec.	9	5	7
Republic	14 ,,	8	17	14
Adriatic	21 ,,	8	22	18
Celtic	27 ,,	8	16	28
.. ..	..	..	..	..
47 Sailings		420	8	43
Average		8	22	39

"CUNARD" LINE.

Wednesday Steamers.	SAILED. Day. Mon. 1873.	MEAN TIME. D.	H.	M.
Cuba	4 Jan.	9	9	53
Parthia	8 ,,	9	12	8
Java	15 ,,	8	19	58
Calabria	22 ,,	10	17	28
Algeria	29 ,,	9	3	0
Cuba	8 Feb.	9	6	46
Parthia	13 ,,	11	10	26
Java	19 ,,	8	21	1
Abyssinia	26 ,,	8	18	9
Algeria	5 Mar.	9	4	22
Calabria	12 ,,	9	4	53
Parthia	20 ,,	10	7	56
Cuba	26 ,,	8	17	6
Abyssinia	2 Apr.	9	1	30
Algeria	10 ,,	9	15	51
Russia	16 ,,	9	4	4
Java	23 ,,	8	17	49
Cuba	30 ,,	8	21	43
Scotia	7 May	8	22	23
Algeria	14 ,,	9	0	31
Russia	21 ,,	8	9	45
Java	28 ,,	9	4	5
Cuba	4 June	9	6	43
Scotia	11 ,,	8	18	51
Algeria	18 ,,	8	21	26
Russia	25 ,,	8	17	0
Java	3 July	8	19	18
Cuba	9 ,,	9	0	33
Scotia	16 ,,	9	0	23
Algeria	23 ,,	9	6	53
Russia	30 ,,	8	18	14
Java	6 Aug.	8	20	25
Cuba	13 ,,	10	0	6
Scotia	20 ,,	9	5	48
Algeria	27 ,,	9	14	56
Russia	3 Sept.	8	11	50
Java	10 ,,	9	5	38
Cuba	17 ,,	9	18	38
Scotia	24 ,,	9	15	28
Algeria	1 Oct.	10	4	18
Russia	8 ,,	10	0	33
Java	15 ,,	9	5	49
Cuba	22 ,,	9	10	58
Scotia	29 ,,	9	20	58
Algeria	5 Nov.	10	2	3
Russia	12 ,,	9	10	37
Java	19 ,,	9	8	58
Cuba	26 ,,	9	5	13
Abyssinia	4 Dec.	10	11	35
Algeria	10 ,,	9	9	10
Russia	18 ,,	9	5	3
Java	24 ,,	9	8	37
Cuba	31 ,,	9	9	10
.. ..	..	..	..	..
53 Sailings		494	13	59
Average		9	7	57

Table III.—Homewards, 1873.—*Continued.*

"INMAN" LINE.					NATIONAL "LINE."				
Saturday Steamers.	Sailed.	Mean Time.			*Saturday Steamers.*	Sailed.	Mean Time.		
	Day. Mon. 1873.	D.	H.	M.		Day. Mon. 1873.	D.	H.	M.
City of New York	6 Jan.	10	7	8	Greece . .	2 Jan.	10	10	8
,, Brooklyn .	11 ,,	8	19	28	Egypt . .	8 ,,	9	4	18
,, Washington	19 ,,	10	14	25	France .	17 ,,	11	9	18
,, Brussels .	25 ,,	8	20	8	Spain . .	23 ,,	10	7	23
,, Antwerp .	1 Feb.	10	5	42	Italy . .	31 ,,	10	23	3
,, London .	8 ,,	9	6	47	Canada .	7 Feb.	10	12	38
,, New York	15 ,,	11	14	55	Greece . .	13 ,,	12	14	18
,, Paris . .	22 ,,	12	16	14	Egypt . .	19 ,,	9	3	1
,, Montreal .	1 Mar.	9	9	38	The Queen	23 ,,	13	0	38
,, Brooklyn	8 ,,	9	7	8	France .	28 ,,	10	11	43
,, Antwerp .	18 ,,	10	5	0	Spain . .	5 Mar.	9	15	58
,, New York	27 ,,	10	13	53	.. ..	..	..	..	..
,, Paris . .	29 ,,	9	2	8	Italy . .	20 ,,	10	14	8
,, Montreal .	6 Apr.	11	12	47	Egypt . .	29 ,,	10	4	21
,, Brooklyn	12 ,,	10	1	3	Canada .	8 Apr.	11	5	48
,, Antwerp .	19 ,,	9	23	1	France .	14 ,,	11	17	58
,, London .	26 ,,	9	15	28	Spain . .	19 ,,	9	22	23
,, Paris . .	3 May	8	19	8	Italy . .	26 ,,	10	17	3
,, Montreal .	10 ,,	9	20	33	Greece . .	3 May	10	15	28
,, Brooklyn	17 ,,	9	20	23	Egypt . .	10 ,,	9	12	38
,, Antwerp .	24 ,,	10	1	25	Canada .	17 ,,	10	13	8
,, London .	31 ,,	9	12	54	Spain . .	24 ,,	10	9	18
,, Paris . .	7 June	9	2	18	Italy . .	31 ,,	10	20	8
,, Montreal .	14 ,,	10	7	15	Greece . .	7 June	10	17	8
,, Brooklyn	21 ,,	9	14	28	Egypt . .	14 ,,	9	19	58
,, Antwerp .	28 ,,	9	18	50	Canada .	21 ,,	10	19	23
,, Paris . .	5 July	9	9	39	Spain . .	28 ,,	8	19	53
,, London .	12 ,,	9	23	22	France . .	5 July	11	3	45
,, Montreal .	20 ,,	10	20	1	Greece . .	12 ,,	10	9	58
,, Chester .	26 ,,	8	9	38	Egypt . .	19 ,,	9	18	48
,, Brooklyn	2 Aug.	9	18	38	Canada .	26 ,,	10	4	28
,, Paris . .	9 ,,	8	22	50	Spain . .	2 Aug.	9	12	23
,, London .	16 ,,	10	11	13	Italy . .	9 ,,	10	10	58
,, Montreal .	23 ,,	11	9	13	Greece . .	16 ,,	11	3	13
,, Chester .	30 ,,	8	2	28	Egypt . .	23 ,,	9	18	13
,, Brussels .	6 Sept.	10	23	28	.. ..	..	..	..	..
,, Paris . .	13 ,,	9	14	9	Spain . .	6 Sept.	9	4	58
,, Richmond	20 ,,	10	2	32	Italy . .	13 ,,	10	23	3
,, Montreal .	27 ,,	9	21	33	France . .	20 ,,	13	20	58
,, Chester .	4 Oct.	8	15	18	Egypt . .	27 ,,	9	20	48
,, Brussels .	11 ,,	8	19	58	Greece . .	4 Oct.	11	6	38
,, Paris . .	18 ,,	9	14	53	Spain . .	11 ,,	9	7	58
,, Richmond	25 ,,	*20	2	45	Italy . .	18 ,,	10	19	13
,, Montreal .	1 Nov.	12	20	5	France . .	28 ,,	12	3	8
,, Chester .	8 ,,	9	3	28	Egypt . .	1 Nov.	10	10	18
,, Brussels .	15 ,,	9	5	42	Greece . .	8 ,,	11	6	13
,, Paris . .	22 ,,	8	20	23	Spain . .	15 ,,	10	9	26
,, Brooklyn	29 ,,	9	5	9	Italy . .	22 ,,	10	4	5
,, London .	6 Dec.	10	3	21	.. ..	..	..	..	..
,, Brussels .	13 ,,	8	9	10	Canada .	3 Dec.	11	22	58
,, Montreal .	20 ,,	10	8	37	Egypt . .	10 ,,	9	21	43
,, Chester .	27 ,,	8	1	35	Greece . .	18 ,,	10	21	8
.. .. ..	..	..	..	..	.. ..	..	..	..	..
.. .. ..	..	..	..	..	Italy . .	28 ,,	10	15	39
52 Sailings .		520	7	15	50 Sailings .		529	17	9
Average . .		10	0	3	Average . .		10	14	16

TABLE III.—HOMEWARDS, 1873.—*Continued.*

"GUION" LINE.					"HAMBURG" LINE.				
Wednesday Steamers.	Sailed.	Mean Time.			*Thursday Steamers.*	Sailed.	Mean Time.		
	Day. Mon.	D.	H.	M.		Day. Mon.	D.	H.	M.
	1873.					1873.			
Wisconsin.	2 Jan.	10	5	38	Hammonia	9 Jan.	10	12	51
.. ..	..	..	..	..	Cimbria .	16 ,,	9	20	21
Nevada .	8 ,,	10	5	8	Silesia . .	23 ,,	11	2	1
Wyoming .	15 ,,	10	5	8	Frisia . .	30 ,,	9	20	51
Idaho . .	22 ,,	11	16	23	Westphalia	6 Feb.	10	14	1
Minnesota.	29 ,,	11	5	28	Thuringia	13 ,,	10	6	51
Manhattan	7 Feb.	12	21	38	Hammonia	20 ,,	10	6	46
Wisconsin.	13 ,,	10	2	34	Cimbria .	28 ,,	10	1	6
Nevada .	19 ,,	10	16	28	Silesia . .	6 Mar.	10	6	51
Wyoming .	26 ,,	10	16	13	Frisia . .	13 ,,	9	21	36
Idaho . .	5 Mar.	11	16	53	Westphalia	21 ,,	9	16	26
Minnesota.	12 ,,	11	11	53	Thuringia.	27 ,,	9	14	21
Manhattan	19 ,,	11	14	53	Hammonia	3 Apr.	11	15	21
Wisconsin.	26 ,,	9	0	58	.. ..	..	..	..	..
Nevada .	2 Apr.	10	20	18	Silesia . .	18 ,,	9	19	21
Wyoming .	10 ,,	10	20	53	Frisia . .	24 ,,	9	20	21
Idaho . .	16 ,,	12	14	8	Westphalia	1 May	9	17	56
Minnesota.	23 ,,	11	5	38	Thuringia.	8 ,,	10	4	21
Manhattan	30 ,,	11	11	8	Hammonia	15 ,,	10	5	1
Wisconsin.	7 May	10	8	53	Holsatia .	22 ,,	9	13	41
Nevada .	14 ,,	9	18	23	Silesia . .	29 ,,	9	21	21
Wyoming .	21 ,,	10	22	8	Frisia . .	5 June	10	5	1
Idaho . .	28 ,,	10	0	58	Westphalia	12 ,,	10	19	31
Minnesota.	4 June	11	11	48	Thuringia.	19 ,,	10	0	51
Manhattan	11 ,,	11	3	28	Cimbria .	26 ,,	10	8	21
Wisconsin.	18 ,,	9	8	48	Hammonia	3 July	9	21	41
Nevada .	25 ,,	10	0	8	Holsatia .	10 ,,	9	12	21
Wyoming .	2 July	9	1	38	Silesia. .	13 ,,	10	5	51
Idaho . .	9 ,,	10	6	8	Frisia . .	24 ,,	9	17	51
Minnesota.	16 ,,	11	10	23	Westphalia	31 ,,	9	14	31
Wisconsin.	23 ,,	10	15	38	Thuringia.	7 Aug.	9	12	51
Nevada .	30 ,,	9	22	13	Cimbria .	14 ,,	10	5	6
Manhattan	6 Aug.	11	1	28	Hammonia	21 ,,	12	5	51
Wyoming .	13 ,,	10	18	8	Holsatia .	28 ,,	9	19	51
Idaho . .	20 ,,	10	13	30	Silesia . .	4 Sept.	9	23	51
Minnesota.	27 ,,	11	15	38	Frisia . .	11 ,,	10	0	31
Wisconsin.	3 Sept.	9	15	23	Westphalia	18 ,,	10	9	31
Nevada .	10 ,,	10	7	23	Thuringia.	25 ,,	9	21	36
Manhattan	17 ,,	12	6	58	Cimbria .	2 Oct.	10	3	41
Wyoming .	28 ,,	10	22	38	Holsatia .	9 ,,	10	3	51
Idaho . .	1 Oct.	10	14	18	Silesia . .	16 ,,	10	5	59
Minnesota.	8 ,,	12	9	33	Frisia . .	23 ,,	9	17	1
Wisconsin.	15 ,,	10	1	38	Westphalia	30 ,,	10	7	31
Nevada .	22 ,,	10	9	38	Thuringia.	6 Nov.	10	13	21
Manhattan	29 ,,	*15	8	53	Cimbria .	13 ,,	10	13	51
Wyoming .	5 Nov.	10	23	8	Holsatia .	20 ,,	9	6	11
Idaho . .	12 ,,	10	11	8	Silesia . .	27 ,,	9	17	51
Minnesota.	19 ,,	10	6	38	Frisia . .	4 Dec.	10	10	21
Wisconsin.	26 ,,	9	18	58	Westphalia	11 ,,	9	20	1
Nevada .	4 Dec	10	10	28	Thuringia.	18 ,,	9	14	21
Manhattan	14 ,,	12	21	13	Pomerania	25 ,,	9	10	1
Wyoming .	18 ,,	9	17	58	.. ..	..	..	..	..
Idaho . .	24 ,,	10	10	38	.. ..	..	..	..	..
Minnesota.	31 ,,	10	12	53	.. ..	..	..	..	..
53 Sailings .		574	20	2	50 Sailings .		505	10	33
Average . .		10	20	18	Average . .		10	2	37

TABLE III.—HOMEWARDS, 1873.—*Continued.*

"BREMEN" LINE.				
Saturday Steamers.	SAILED.	MEAN TIME.		
	Day. Mon. 1873.	D.	H.	M.
Bremen .	4 Jan.	10	8	40
.. ..	..	..	..	
Rhein . .	11 ,,	9	8	30
Main . .	19 ,,	10	7	40
Hansa . .	25 ,,	10	4	10
Mosel . .	1 Feb.	10	21	55
Weser . .	8 ,,	9	19	20
America .	15 ,,	12	0	40
Bremen .	22 ,,	10	15	30
Donau . .	1 Mar.	9	17	5
Main . .	8 ,,	10	23	10
Deutschland	15 ,,	10	10	30
Mosel . .	22 ,,	9	21	50
Rhein . .	29 ,,	9	21	50
Weser . .	5 Apr.	10	18	50
Donau . .	12 ,,	10	10	20
Main . .	19 ,,	9	18	10
Deutschland	26 ,,	10	2	40
Mosel . .	3 May	9	23	45
Rhein . .	10 ,,	9	18	50
Weser . .	17 ,,	9	22	10
Donau . .	24 ,,	10	0	25
Main . .	31 ,,	9	13	40
Deutschland	7 June	10	2	35
Hermann .	14 ,,	10	10	40
Mosel . .	21 ,,	9	19	0
Rhein . .	28 ,,	9	8	10
Donau . .	5 July	9	9	10
Main . .	12 ,,	9	17	55
Deutschland	19 ,,	10	10	40
Hermann .	26 ,,	10	18	0
Mosel . .	2 Aug.	10	5	10
Rhein . .	9 ,,	9	13	55
Weser . .	16 ,,	10	10	20
Main . .	23 ,,	9	19	55
Deutschland	30 ,,	10	9	40
Hermann .	6 Sept.	10	7	25
Mosel . .	13 ,,	10	15	35
Rhein . .	20 ,,	11	13	30
Weser . .	27 ,,	10	1	0
Main . .	4 Oct.	9	17	25
Deutschland	11 ,,	10	16	55
Donau . .	18 ,,	10	7	20
Mosel . .	25 ,,	11	1	10
Hermann .	1 Nov.	11	7	40
Rhein . .	8 ,,	10	8	20
Weser . .	15 ,,	10	5	10
Hansa . .	22 ,,	11	1	0
Main . .	29 ,,	9	20	20
Deutschland	6 Dec.	10	15	40
Donau . .	13 ,,	9	13	10
Mosel . .	20 ,,	10	11	25
Hermann .	28 ,,	10	7	50
.. ..	..	..	..	
52 Sailings .		533	11	45
Average . .		10	6	14

LINE.	White Star Line	Cunard Line	Inman Line	National Line	Guion Line	Hamburg Line	Bremen Line
Over 7½ and under 8 days.	1	..	..	..	..	..	..
Over 8 and under 8½ days.	8	2	4	..	..	..	..
Over 8½ and under 9 days.	20	13	7	..	..	..	..
Over 9 and under 9½ days.	13	24	9	4	3	2	3
Over 9½ and under 10 days.	1	6	12	9	5	22	16
Over 10 and under 10½ days.	2	6	10	11	15	18	20
Over 10½ and under 11 days.	2	1	4	13	12	5	8
Over 11 and under 11½ days.	..	1	1	6	8	1	3
Over 11½ and under 12 days.	..	..	2	2	4	1	1
Over 12 and under 13 days.	..	..	2	2	5	1	1
Over 13 and under 14 days.	..	..	..	2	..	..	..
Over 14 and under 15 days.	..	..	..	..	..	..	..
Over 15 and under 16 days.	..	..	..	..	1	..	..
Over 16 and under 17 days.	..	..	..	..	..	..	..
Over 17 and under 18 days.	..	..	..	..	..	..	..
Over 18 and under 19 days.	..	..	..	..	..	..	..
Over 19 and under 20 days.	..	..	..	..	..	..	..
Over 20 and under 21 days.	..	..	1	..	..	..	..
Over 21 and under 22 days.	..	..	..	..	..	..	..
Over 22 and under 23 days.	..	..	..	..	..	..	..
NO. OF VOYAGES.	47	58	52	50	53	50	52
DURATION. D. H. M.	420 8 43	494 13 59	520 7 15	529 17 9	574 20 12	505 10 33	533 11 45
AVERAGE. D. H. M.	8 22 39	9 7 59	10 0 3	10 14 16	10 20 18	10 2 37	10 6 14

TABLE IV.—HOMEWARDS, 1874.—*Statement of Passages made to the Eastward during 1874 by Steamers of the White Star, Cunard, Inman, National, and Guion Lines to Queenstown (2777 Miles), and of Bremen (N. German Lloyd's) Line to Southampton (2995 Miles), and of Hamburg-American Line to Plymouth, all from Sandy Hook (N.Y.). (See footnote, page 286.)*

"WHITE STAR" LINE.					"CUNARD" LINE.				
Saturday Steamers.	SAILED.	MEAN TIME.			*Wednesday Steamers.*	SAILED.	MEAN TIME.		
	Day. Mon. 1874.	D.	H.	M.		Day. Mon. 1874.	D.	H.	M.
Baltic . .	4 Jan.	8	12	13	Calabria .	8 Jan.	9	6	28
Oceanic .	10 ,,	9	12	48	Algeria .	14 ,,	9	6	0
Republic .	17 ,,	9	11	16	Russia .	21 ,,	8	22	2
Adriatic .	24 ,,	8	6	18	Java . .	28 ,,	9	6	45
.. ..	..	..	..		Abyssinia .	4 Feb.	8	17	53
Baltic . .	7 Feb.	8	1	48	Calabria .	11 ,,	8	23	30
Oceanic .	14 ,,	9	12	38	Algeria .	18 ,,	9	15	31
Republic .	22 ,,	9	12	8	Russia . .	26 ,,	10	2	5
Celtic . .	28 ,,	9	4	33	Cuba . .	4 Mar.	10	1	53
Adriatic .	7 Mar.	8	13	23	Abyssinia .	11 ,,	8	19	56
Baltic . .	14 ,,	8	15	8	Calabria .	20 ,,	9	1	31
Oceanic .	21 ,,	9	7	4	Algeria .	25 ,,	9	10	11
Republic .	28 ,,	8	22	12	Java . .	1 Apr.	8	16	48
Celtic . .	5 Apr.	9	2	58	Cuba . .	8 ,,	9	3	38
Adriatic .	11 ,,	8	6	28	Abyssinia .	15 ,,	9	11	28
Baltic . .	19 ,,	9	9	48	Russia .	22 ,,	9	5	14
Oceanic .	26 ,,	9	6	18	Calabria .	29 ,,	9	4	25
Republic .	2 May	9	6	58	Scotia . .	6 May	8	19	3
Celtic . .	9 ,,	8	15	50	Cuba . .	13 ,,	9	14	38
Adriatic .	16 ,,	8	4	56	Abyssinia .	20 ,,	9	9	13
Baltic . .	23 ,,	8	4	17	Russia . .	27 ,,	8	21	38
Oceanic .	31 ,,	9	12	13	Calabria .	4 June	9	9	58
Republic .	6 June	8	13	30	Scotia . .	10 ,,	8	22	23
Celtic . .	13 ,,	8	15	11	Cuba . .	17 ,,	9	10	24
Adriatic .	20 ,,	8	10	6	Abyssinia .	24 ,,	9	1	45
.. ..	..	..	..		Russia . .	1 July	9	0	51
Oceanic .	4 July	9	12	14	Calabria .	8 ,,	9	3	48
Britannic .	11 ,,	8	18	21	Scotia . .	15 ,,	8	19	18
Celtic . .	18 ,,	8	4	46	Cuba . .	22 ,,	9	6	34
Adriatic .	25 ,,	8	6	33	Abyssinia .	29 ,,	9	2	0
Republic .	1 Aug.	8	12	57	Russia .	5 Aug.	8	23	6
Baltic . .	8 ,,	8	4	23	Calabria .	12 ,,	9	15	2
Britannic .	15 ,,	9	2	19	Scotia . .	19 ,,	8	15	58
Celtic . .	22 ,,	8	14	28	Bothnia .	26 ,,	9	7	47
Oceanic .	29 ,,	9	5	53	Abyssinia .	2 Sept.	8	23	43
Republic .	5 Sept.	8	22	38	Russia . .	9 ,,	8	15	19
Baltic . .	12 ,,	8	8	18	Cuba . .	16 ,,	10	2	31
Britannic .	19 ,,	8	17	28	Scotia . .	23 ,,	10	15	13
Celtic . .	26 ,,	8	17	58	Algeria .	30 ,,	8	23	58
Oceanic .	3 Oct.	9	8	43	Abyssinia .	7 Oct.	9	11	43
Republic .	10 ,,	9	2	56	Russia .	14 ,,	8	15	56
Baltic . .	17 ,,	8	6	38	Bothnia .	21 ,,	9	3	3
Adriatic .	28 ,,	7	23	12	Cuba . .	28 ,,	9	7	6
Celtic . .	31 ,,	8	15	42	Algeria .	4 Nov.	10	3	33
Oceanic .	7 Nov.	9	2	46	Abyssinia .	11 ,,	9	4	43
Republic .	14 ,,	8	22	23	Russia .	18 ,,	8	19	8
Baltic . .	21 ,,	8	10	21	Java . .	25 ,,	9	4	52
Gaelic .	29 ,,	10	3	11	Parthia .	2 Dec.	10	10	3
Celtic . .	5 Dec.	8	12	43	Algeria .	9 ,,	9	12	18
Oceanic .	12 ,,	9	8	53	Abyssinia .	16 ,,	9	1	23
Republic .	19 ,,	8	23	48	Russia .	23 ,,	8	17	55
Belgic . .	25 ,,	10	1	33	Java . .	30 ,,	9	3	23
.. ..	..	..	..		.. ..	..	..	..	
50 Sailings .		443	3	7	52 Sailings .		480	22	34
Average . .		8	20	42	Average . .		9	5	46

TABLE IV.—HOMEWARDS, 1874.—*Continued.*

"INMAN" LINE.

Saturday Steamers.	Sailed. Day. Mon. 1874.	Mean Time. D.	H.	M.
City of New York	4 Jan.	10	5	31
,, Antwerp	10 ,,	10	8	49
,, Brooklyn	17 ,,	10	9	56
,, Brussels	24 ,,	8	16	33
,, Montreal	31 ,,	12	0	26
,, Chester .	7 Feb.	8	5	58
,, New York	14 ,,	10	3	58
,, Brooklyn	22 ,,	9	14	36
,, Brussels	28 ,,	9	17	0
,, Montreal	12 Mar.	11	8	28
,, Baltimore	14 ,,	9	21	31
,, Richmond	21 ,,	8	12	17
,, Brooklyn	28 ,,	9	9	53
,, Brussels	5 Apr.	9	6	10
,, Paris .	11 ,,	9	2	8
,, Montreal	23 ,,	10	20	43
,, Richmond	26 ,,	8	2	38
,, Brooklyn	2 May	9	15	43
,, Brussels	9 ,,	9	3	38
,, Chester .	16 ,,	8	11	28
,, Richmond	23 ,,	8	9	43
,, Paris .	31 ,,	9	0	13
,, Brooklyn	6 June	9	13	4
,, Brussels	13 ,,	9	4	41
,, Chester .	20 ,,	8	1	58
,, Richmond	27 ,,	8	18	23
,, Paris .	4 July	9	4	38
,, Montreal	11 ,,	9	15	58
,, Brooklyn	18 ,,	9	19	5
,, Chester .	25 ,,	8	4	33
,, Richmond	3 Aug.	8	7	23
,, Paris .	8 ,,	9	6	8
,, Montreal	15 ,,	9	15	13
,, Brussels	22 ,,	8	21	20
,, Chester .	29 ,,	8	5	38
,, Richmond	5 Sept.	8	22	38
,, Paris .	12 ,,	9	12	8
,, Montreal	19 ,,	10	4	33
,, Brussels	26 ,,	8	23	1
,, Chester .	3 Oct.	8	8	38
,, Richmond	10 ,,	8	3	1
,, Paris .	17 ,,	9	10	5
,, Montreal	24 ,,	10	14	43
,, Antwerp	31 ,,	10	5	22
,, Brooklyn	7 Nov.	9	1	21
,, New York	14 ,,	10	11	31
,, London .	22 ,,	11	11	13
,, Montreal	3 Dec.	9	21	25
,, Antwerp	8 ,,	9	23	48
,, Brooklyn	12 ,,	9	6	28
,, New York	22 ,,	10	3	14
.. ..	..	..	..	
.. ..	..	..	..	
51 Sailings .		482	0	31
Average . .		9	10	50

"NATIONAL" LINE.

Saturday Steamers.	Sailed. Day. Mon. 1874.	Mean Time. D.	H.	M.
Spain . .	4 Jan.	9	17	38
Canada .	13 ,,	11	2	48
Egypt . .	17 ,,	10	1	8
Greece .	24 ,,	10	22	8
Italy . .	31 ,,	12	8	8
Spain . .	7 Feb.	9	9	41
Canada .	17 ,,	12	0	38
Egypt . .	21 ,,	9	8	38
Greece .	6 Mar.	11	7	28
Italy . .	11 ,,	11	2	8
Spain . .	15 ,,	10	8	8
Canada .	26 ,,	12	3	58
Egypt . .	28 ,,	9	22	53
.. ..	..		..	..
Greece .	18 ,,	11	20	18
Italy . .	23 ,,	11	17	53
Spain . .	26 ,,	9	21	38
Egypt . .	2 May	9	11	38
The Queen	9 ,,	10	4	28
Canada .	16 ,,	10	14	58
.. ..	..		..	..
Spain . .	31 ,,	10	9	13
Greece. .	7 June	10	15	38
Egypt . .	13 ,,	9	22	38
The Queen	20 ,,	9	22	53
Italy . .	27 ,,	11	2	23
Spain . .	4 July	10	7	13
Canada .	11 ,,	11	0	48
Greece .	19 ,,	11	7	38
Egypt . .	25 ,,	9	10	18
The Queen	1 Aug.	9	23	2
Italy . .	8 ,,	10	23	58
Spain . .	15 ,,	10	3	13
Canada .	22 ,,	11	3	38
Egypt . .	29 ,,	9	17	43
The Queen	5 Sept.	10	2	28
England	12 ,,	11	12	13
Spain . .	19 ,,	10	8	23
Erin . .	26 ,,	10	16	8
Egypt . .	3 Oct.	9	12	38
The Queen	10 ,,	10	4	53
Denmark .	21 ,,	12	2	58
England .	27 ,,	10	13	26
Spain . .	31 ,,	9	17	8
Erin . .	11 Nov.	10	21	8
Egypt . .	14 ,,	9	21	28
Italy . .	21 ,,	11	19	43
The Queen	29 ,,	9	23	5
England .	10 Dec.	10	20	43
Spain . .	12 ,,	10	10	8
Helvetia .	19 ,,	11	1	3
Erin . .	26 ,,	10	19	13
.. ..	..		..	..
50 Sailings .		530	3	17
Average . .		10	14	28

TABLE IV.—HOMEWARDS, 1874.—*Continued.*

"GUION" LINE.					"BREMEN" LINE.				
Tuesday Steamers.	SAILED.	MEAN TIME.			*Thursday Steamers.*	SAILED.	MEAN TIME.		
	Day. Mon. 1874.	D.	H.	M.		Day. Mon. 1874.	D.	H.	M.
Wisconsin .	6 Jan.	9	13	48	Rhein . .	4 Jan.	9	12	20
Nevada .	13 ,,	9	19	23	Weser . .	10 ,,	9	17	55
Wyoming .	20 ,,	9	21	8	New York .	17 ,,	12	5	25
Idaho . .	27 ,,	10	19	43	Main . . .	24 ,,	9	18	0
Manhattan	4 Feb.	10	11	13	Donau . .	31 ,,	12	11	5
Minnesota.	10 ,,	10	2	18	Mosel . .	7 Feb.	9	18	40
Wisconsin .	17 ,,	*21	4	3	Hermann .	14 ,,	10	13	0
Nevada .	24 ,,	11	1	38	Hansa . .	21 ,,	11	6	50
.. ..	..	..	..		Weser . .	28 ,,	10	20	25
Idaho . .	10 Mar.	9	23	38	Rhein . .	7 Mar.	10	7	40
Manhattan	18 ,,	11	9	28	Main . .	14 ,,	9	22	55
Minnesota.	24 ,,	10	8	53	Donau . .	21 ,,	9	22	25
Wyoming .	31 ,,	9	11	8	Mosel . .	28 ,,	10	5	0
Nevada .	8 Apr.	10	20	38	Hermann .	4 Apr.	10	13	35
.. ..	..	..	..		Weser . .	11 ,,	10	5	40
Idaho . .	21 ,,	11	2	33	Rhein . .	18 ,,	10	10	40
Wisconsin.	28 ,,	9	14	38	Main . .	26 ,,	9	20	40
Minnesota.	6 May	10	22	38	Donau . .	2 May	9	18	35
Wyoming .	12 ,,	10	15	58	Neckar . .	9 ,,	10	3	10
.. ..	..	..	..		Mosel . .	16 ,,	9	19	40
Nevada .	26 ,,	10	8	38	Weser . .	23 ,,	9	21	10
Idaho . .	2 June	10	6	38	Rhein . .	30 ,,	10	0	55
Wisconsin.	9 ,,	10	12	8	Main . .	7 June	10	19	40
Minnesota.	16 ,,	11	4	8	Oder . . .	13 ,,	10	0	0
Wyoming .	23 ,,	9	20	28	Neckar . .	20 ,,	10	4	10
Nevada .	30 ,,	11	13	38	Mosel . .	27 ,,	9	8	50
.: ..	..	..	..		America . .	4 July	11	23	45
Idaho . .	14 July	10	16	8	Rhein . .	11 ,,	10	1	45
Wisconsin.	22 ,,	11	4	8	Main . .	18 ,,	10	5	0
Minnesota.	28 ,,	10	14	38	Oder . .	25 ,,	10	8	5
Wyoming .	4 Aug.	9	21	18	Neckar . .	1 Aug.	10	7	40
.. ..	..	..	..		Mosel . .	8 ,,	9	20	55
Nevada .	18 ,,	10	3	38	America . .	15 ,,	10	20	55
Idaho . .	25 ,,	10	21	13	Deutschland.	22 ,,	10	5	10
Wisconsin.	1 Sept.	9	12	38	Weser . .	29 ,,	10	5	50
Minnesota.	8 ,,	10	13	38	Main . . .	5 Sept.	9	21	10
.. ..	..	..	..		Neckar . .	12 ,,	10	2	50
Wyoming .	22 ,,	9	23	38	Donau . .	19 ,,	9	17	30
Nevada .	30 ,,	9	16	8	Hohenstauffen	26 ,,	11	3	35
Idaho . .	6 Oct.	10	19	38	America . .	3 Oct.	10	23	20
Wisconsin.	13 ,,	9	18	38	Hermann .	10 ,,	11	0	0
Minnesota.	20 ,,	11	3	38	Rhein . .	17 ,,	9	23	40
.. ..	..	..	..		Main . .	24 ,,	10	8	0
Wyoming .	3 Nov.	10	2	28	Oder . . .	31 ,,	9	12	10
Nevada .	12 ,,	10	16	23	Necker . .	7 Nov.	9	17	50
.. ..	..	..	..		Donau . .	14 ,,	9	18	30
Wisconsin.	25 ,,	9	20	38	Hohenstauffen	21 ,,	11	20	45
.. ..	..	..	..		America . .	29 ,,	11	1	10
Minnesota.	10 Dec.	10	15	33	Hermann .	5 Dec.	10	5	40
.. ..	..	..	..		Deutschland	12 ,,	9	22	20
Wyoming .	22 ,,	9	15	58	Hansa . .	19 ,,	12	0	25
.. ..	..	..	..		Oder . . .	26 ,,	9	15	30
.. ..	..	..	..		.. ..	..	..	..	
41 Sailings .		457	13	28	52 Sailings .		539	10	35
Average . .		10	16	8	Average . .		10	8	58

TABLE IV.—HOMEWARDS, 1874.—*Continued.*

"HAMBURG" LINE.

Saturday Steamers.	Sailed. Day. Mon. 1874.		Mean Time. D.	H.	M.
Holsatia .	1	Jan.	9	14	51
Cimbria .	8	,,	10	9	1
Hammonia	15	,,	9	20	56
Silesia . .	22	,,	9	17	21
Frisia . .	29	,,	9	7	6
Westphalia	5	Feb.	9	8	51
Thuringia .	12	,,	9	10	11
Pomerania	19	,,	9	20	21
Holsatia .	26	,,	9	21	21
Hammonia	5	Mar.	10	16	51
.. ..		..	..	..	
Frisia . .	20	,,	9	15	21
Thuringia.	26	,,	9	19	21
Westphalia	2	Apr.	9	16	46
Silesia .	11	,,	10	0	0
Holsatia .	16	,,	9	19	3
Hammonia	23	,,	10	17	51
Frisia . .	30	,,	9	18	51
Thuringia.	7	May	10	0	17
Westphalia	14	,,	10	4	6
Pomerania	21	,,	9	18	51
Holsatia .	28	,,	9	9	31
Silesia .	4	June	10	1	51
Frisia . .	11	,,	9	16	51
Thuringia.	18	,,	9	15	54
Westphalia	25	,,	10	8	36
Pomerania	2	July	10	0	21
Holsatia .	9	,,	9	12	11
Silesia . .	16	,,	10	3	6
Hammonia	23	,,	10	3	11
Frisia . .	30	,,	9	17	6
Thuringia.	6	Aug.	9	17	51
Westphalia	13	,,	13	0	0
Pomerania	20	,,	10	0	51
Holsatia .	27	,,	10	0	56
Cimbria .	3	Sept.	10	17	21
Hammonia	10	,,	9	22	16
Frisia . .	17	,,	10	11	21
Thuringia.	24	,,	9	23	51
Pomerania	1	Oct.	9	12	50
Silesia . .	8	,,	9	15	31
Holsatia .	15	,,	9	12	6
Cimbria .	22	,,	10	0	0
Frisia . .	29	,,	10	0	0
Thuringia.	5	Nov.	10	13	41
Suevia .	12	,,	11	3	36
Westphalia	19	,,	9	18	24
Pomerania	26	,,	10	12	21
Silesia . .	3	Dec.	9	15	36
Holsatia .	10	,,	9	10	58
Cimbria .	17	,,	9	21	21
Frisia . .	24	,,	9	15	6
Westphalia	31	,,	10	22	36
52 Sailings .			521	3	8
Average . .			10	0	31

Line.	Over 7¾ and under 8 days.	Over 8 and under 8½ days.	Over 8½ and under 9 days.	Over 9 and under 9½ days.	Over 9½ and under 10 days.	Over 10 and under 10½ days.	Over 10½ and under 11 days.	Over 11 and under 11½ days.	Over 11½ and under 12 days.	Over 12 and under 13 days.	Over 13 and under 14 days.	Over 14 and under 15 days.	Over 15 and under 16 days.	Over 16 and under 17 days.	Over 17 and under 18 days.	Over 18 and under 19 days.	Over 19 and under 20 days.	Over 20 and under 21 days.	Over 21 and under 22 days.	No. of Sailings in 1874.	Duration. D.	H.	M.	Average. D.	H.	M.
White Star Line	1	12	17	13	5	2	..	..	..	..	..	..	..	..	..	..	..	..	..	50	443	3	7	8	20	42
Cunard Line .	..	..	17	25	4	5	1	..	..	..	..	..	..	..	..	..	..	..	..	52	480	22	34	9	5	46
Inman Line .	..	10	6	11	11	8	2	2	1	..	..	..	..	..	..	..	..	..	..	51	482	0	31	9	10	50
National Line .	..	..	..	4	11	10	9	8	4	4	..	..	..	..	..	..	..	..	..	50	530	3	17	10	14	28
Guion Line .	..	..	..	1	13	7	12	6	1	..	..	..	..	..	..	..	..	..	1	41	437	13	28	10	16	8
Bremen Line .	..	..	..	1	19	17	6	4	2	3	..	..	..	..	..	..	..	..	..	52	539	10	35	10	8	58
Hamburg Line	..	..	..	5	25	14	6	1	..	..	1	..	..	..	..	..	..	..	..	52	521	3	8	10	0	31

APPENDIX No. 18. Vol. iv., p. 287.

Particulars of the "Anchor" Line of Steamers.

Screw Steamships.	Tonnage.		Dimensions.			Horse Power.
	Gross.	Nett.	Length.	Breadth.	Depth.	
Acadia . . .	1,081	697	264·8	26·4	20·2	200
Alexandria . .	1,629	1,055	300·5	33·2·5	22·6	424
Alsatia . . .	2,820	2,024	355·	36·	22 × 29	800
Anchoria . .	4,206	2,880	408·	40·	26 × 34	1,120
Anglia . . .	2,253	1,412	325·3	35·	22·5	400
Assyria . . .	1,623	1,052	300·5	33·2·5	22·6	424
Australia . .	2,243	1,384	324·6	35·2	22·5	400
Bolivia . . .	4,050	2,625	400·	40·	25·1·5 × 33	1,120
Caledonia . .	2,125	1,595	310·6	33·3	21·4·5	424
California . .	3,287	2,096	361·5	40·5	24·2·5 × 31·6	1,047
Castalia . . .	2,200	1,660	306·6	34·6	21·8 × 29·2	424
Columbia . .	1,697	1,367	283·3	33·6·5	22·2·5	400
Concordia . .	4,206	2,880	408·	40·	26 × 34	1,120
Dorian . . .	1,038	667	237·5	30·2	19·9	100
Elysia . . .	2,733	1,753	351·	35·0·5	22·1 × 29·7	678
Ethiopia . .	4,004	2,604	402·	40·2	24·8·5 × 33·0·5	1,120
Europa . . .	2,277	1,737	338·5	33·7·5	22·1·5 × 29	424
India . . .	2,289	1,444	311·6	36·7	23·6	500
Italia . . .	2,245	1,451	306·	34·4	21·9 × 29·1·1	424
Macedonia . .	2,272	1,452	315·	34·	24 × 31·2	486
Napoli . . .	843	672	252·4	25·2·5	16·5·5	100
Nubia . . .	4,206	2,880	408·	40·	26 × 34	1,120
Olympia. . .	2,050	1,527	307·1	34·6	21·8 × 29	424
Scandinavian .	1,135	918	258·2	26·1	15·9 × 23·5·5	96
Scotia . . .	1,103	844	261·1	26·2	20·7	120
Sidonia . . .	1,235	799	258·	32·	21·	203
Trinacria . .	2,107	1,342	306·	34·4	22 × 29	424
Tyrian . . .	1,038	667	237·5	30·2	19·9	100
Utopia . . .	2,731	1,753	350·2·5	35·2	22·2 × 29·5	678
Victoria . . .	3,242	2,081	360·	40·1	24·0·2 × 31·9·1	1,047
Dispatch . .	167	106	119·	21·1	10·6	70
Sailing Ship Shamrock	1,193	..	187·5	37·	24·2	..
Totals . .	71,328	47,474				15,417

APPENDIX No. 19. Vol. iv., p. 312.

The following is a List of the Fleet of the Royal Mail West India Steam-Packet Company, 1st January, 1875.

Name.	Reg. Ton.	H.P.
1. Shannon	3,472	800
2. Boyne (screw)	3,318	500
3. Tagus (screw)	3,252	600
4. Moselle (screw)	3,252	600
5. Elbe (screw)	3,063	600
6. Neva (screw)	2,999	600
7. Nile (screw)	2,994	600
8. Tasmanian (screw)	2,956	600
9. Douro (screw)	2,824	500
10. Mondego (screw)	2,564	450
11. Minho (screw)	2,540	450
12. Tyne (paddle)	1,916	400
13. Dee	1,857	220
14. Essequibo (screw)	1,817	170
15. Severn (screw)	1,736	220
16. Larne (screw)	1,664	180
17. Tiber (screw)	1,591	350
18. Eider (paddle)	1,564	300
19. Ebro (screw)	1,509	350
20. Corsica (screw)	1,134	200
21. Arno (paddle)	1,038	250
22. Belize (screw)	1,015	160
23. Mersey (paddle)	1,001	250
	51,076	9.350
24. Parana (coal-hulk)	2,730	

APPENDIX No. 20. Vol. iv., p. 342.

Pacific Steam Navigation Company. List of the Company's Fleet.

Steamers employed on Liverpool, Valparaiso, and Callao Line.

(*The whole Fleet on the 1st January*, 1875, *consisted of* 54 *Steamers of* 119·870 *aggregate Tons and* 21·395 *H.P.*)

Name.	Tonnage.		Dimensions.			Date of Contract.	Builders.	Total Price.	Capacity.		Consumption per hour.	Displacement at 20 feet.
	Gross Register.	Net Register.	Length between Perpendiculars.	Beam.	Depth.				Cargo.	Coal.		
								£.			Cwts.	
Magellan	2,856	1,791	343·6	41	26·1	Jan. 1868	Randolph, Elder, & Co.	81,628	93,100	25,877	32¾	4,795
Patagonia	2,866	1,798	343·6	41	26·5	Jan. 1868	,, ,,	81,778	93,100	25,877	34½	4,795
Araucania	2,877	1,806	343·6	41	26	April, 1868	,, ,,	81,301	93,100	25,877	34	4,795
Cordillera	2,860	1,791	343·6	41	26	April, 1868	,, ,,	80,977	93,100	25,877	31¼	4,795
Chimborazo	3,847	2,443	370	41	35	Mar. 1870	J. Elder and Co.	91,210	137,850	48,805	45¼	4,996
Cuzco	3,845	2,436	370	41	35	Mar. 1870	,, ,,	93,838	137,850	48,805	40	4,996
Garonne	3,871	2,464	370	41	35·5	Apr. 1870	Napier and Sons	92,765	137,850	48,805	41¼	4,965
John Elder.	3,832	2,430	370	41·5	35·2	Oct. 1869	J. Elder and Co.	113,038	139,730	38,346	47½	4,996
Lengthened	4,151	2,650	406·4	41·5	35·2	.. ..	.. .. ..	..	..	..	..	5,464
Lusitania	3,825	2,420	370	41	35·6	Apr. 1870	Laird Brothers	91,852	137,850	48,805	42¾	5,004
Aconcagua	4,105	2,639	404	41	35·3	Mar. 1870	J. Elder and Co.	103,558	136,496	40,347	49	5,459
Sorata	4,013	2,573	390	42·8	34	May, 1871	,, ,,	108,055	134,790	34,959	48¾	5,415
Illimani	4,022	2,579	390	42·8	34	May, 1871	,, ,,	109,026	134,790	34,959	56¼	5,415
Cotopaxi	4,022	2,579	390	42·8	34	May, 1871	,, ,,	108,898	134,790	34,959	52	5,415
Galicia	3,829	2,449	375	43	33·6	Dec. 1871	Napier and Sons	119,971	127,417	38,852	37½	5,140
Corcovado	3,805	2,405	375	43	33	Nov. 1871	Laird Brothers	119,712	129,050	38,700	49¼	5,150
Puno	3,805	2,405	375	43	33	Nov. 1871	,, ,,	119,651	129,050	38,700	47¾	5,150
Potosi	4,218	2,703	411	43	33·6	Nov. 1871	J. Elder and Co.	135,209	153,100	894 tons.	49½	5,791
Valparaiso	3,575	2,284	370	42	33·4	Aug. 1872	,, ,,	130,496	130,396	31,863	48½	4,927
Britannia	4,081	2,700	399	43	33	Feb. 1872	Laird Brothers	142,520	146,460	39,732	51½	5,613
Iberia	4,671	2,982	425	44·5	37	Jan. 1873	J. Elder and Co.	152,815	..	..	..	5,938
Liguria	..	..	425	44·5	37	Jan. 1873	,, ,,	151,565	..	..	..	5,938

APPENDIX No. 20—*Continued.*

Steamers employed on West Coast Line.

Name.	Tonnage. Gross.	Tonnage. Nett.	Dimensions. Length.	Dimensions. Beam.	Dimensions. Depth.	Date of Contract.	Builders.				Consumption per hour.
											Cwts.
Callao	1,062	840	235	29	16	.. ..	John Reid and Co.	35,689	..	450	28
Chile	1,671	1,173	274	36	15	Nov. 1862	R. Elder and Co.	54,071	270	1,412	22
Guayaquil	660	449	208	30	18	.. ..	Lawrence Hill and Co.	18,878	..	..	12
Huacho	329	249	149	25	11	Feb. 1870	T. Royden and Sons	6,448	..	376	7
Limena	1,622	1,162	267	40	17	June, 1864	R. Elder and Co.	62,011	307	1,520	27
Pacific	1,630	1,174	267	40	17	April, 1864	,, ,,	61,855	307	1,520	27
Panama	1,642	1,177	267	40	17	Aug. 1865	,, ,,	62,779	307	1,550	27
Payta	1,344	996	268	38	14	July, 1863	,, ,,	54,004	295	1,300	18
Peru	1,307	904	260	32	15	Jan. 1861	John Reid and Co.	44,916	..	800	39
Peruano	629	404	181	29	11	Bought	.. .. ..	20,637	..	..	9
Quito	743	469	204	30	14	Nov. 1862	R. Elder and Co.	32,379	120	598	11
San Carlos	652	448	199	30	18	June, 1859	W. Simonds	18,837	..	..	12
Supe	298	230	145	25	10	Sept. 1866	R. Elder and Co.	8,114	44	375	3
Talca	707	469	194	30	16	Mar 1861	,, ,,	23,234	90	410	9
Arequipa	1,065	662	231	35	14	Mar. 1869	,, ,,	39,705	180	755	13
Atacama	1,821	1,131	291	38	22	Nov. 1869		40,880	271	2,185	22
Valdivia	1,860	1,159	301	38	22	Nov. 1869		40,777	246	2,195	17
Coquimbo	1,820	1,130	290	38	22	Jan. 1870		44,024	271	2,185	16
Caldera	1,740	1,051	282	34	17	Bought		37,009	334	1,181	17½
Eten	1,853	1,135	305	38	21	Mar. 1871		47,753	256	2,017	16
Iquique	323	194	149	25	11	Sept 1870		9,728	..	375	7
Ilo	1,794	1,129	303	38	21	Mar. 1871		48,518	250	2,017	12
Santa Rosa	1,816	1,250	320	38	21	Jan. 1872	Laird Brothers	69,781	300	1,460	16
Santiago	1,451	979	266	35	14	Nov. 1870	J. Elder and Co.	45,475	210	823	12
Truxillo	1,449	978	266	35	14	Nov. 1870	,, ,,	45,295	210	823	12
Colombia	1,850	1,250	320	38	20	Jan. 1872	Laird Brothers	70,249	300	1,460	17
Islay	1,577	1,099	270	35	15	Nov. 1871	J. Elder and Co.	59,149	210	847	15
Oroya	1,577	1,099	270	35	15	Nov. 1871	,, ,,	57,444	210	847	16
Ayacucho	1,915	1,308	321	38	21	Jan. 1873	T. Wingate and Co.	70,083	340	1,792	24
Lima	1,803	1,132	300	38	21	April, 1872	,, ,,	72,140	311	..	25
Tacna	612	322	219	26	13	May, 1872	Bowdler, Chaffer, and Co.	80,000	120	325	9
Tabonguilla	154	85	115	21	7·9	Nov. 1870	,, ,, ,,	5,850	..	..	..
Bolivia	1,925	1,215	321	38	21	Jan. 1873	T. Wingate and Co.	67,000	310	1,792	24

APPENDIX No. 21. Vol. iv., p. 333.

Liverpool, Brazil and River Plate Steam Navigation Company (Limited), 1875.

Steamers.	Register Tonnage. Nett.	Register Tonnage. Gross.	Steamers.	Register Tonnage. Nett.	Register Tonnage. Gross.
Kepler	1,759	2,257	Brought forward	15,707	22,718
Newton	839	1,324	Tycho Brahe . .	1,256	1,848
Ptolemy	758	1,115	Hipparchus . . .	1,251	1,840
Halley	994	1,347	Biela	1,401	2,169
Humboldt	994	1,346	Olbers	1,388	2,161
Copernicus . . .	950	1,397	Galileo	1,445	2,262
Memnon	822	1,209	Leibnitz	1,455	2,280
Rubens	1,266	1,707	Gassendi . . .	800	1,249
Teniers	1,017	1,597	Delambre . . .	988	1,308
Vandyck	1,098	1,686	Thales	964	1,487
Memling	632	1,007	Hevelius . . .	1,681	2,610
Maraldi	638	1,002	Maskelyne . . .	1,677	2,605
Lalande	678	1,047	Camoens . . .	659	1,053
Laplace	901	1,409	Calderon . . .	659	1,053
Donati	946	1,392	Cervantes . . .	698	1,131
Pascal	1,415	1,876	Archimedes . . .	966	1,520
Carried forward .	15,707	22,718		32,995	49,294

APPENDIX No. 22. Vol. iv., p. 413.

Abstract of Log of the P. & O. Ship "Khedive," on her Voyage from Alexandria to Southampton.—October, 1873.

Date.	Winds.	Courses.	Distance. Miles.	Latitude.	Longitude.	Total. Miles.	Total. Hrs. M.	Remarks.
				N.	E.			
Oct. 5	N.W.	Various	10	31·15	29·45	823	77·30	Moderate winds and weather throughout.
,, 6	,,	N. 66° W.	254	32·57	25·11			
,, 7	,,	N. 74° W.	254	34·28	20·02			
,, 8	N.N.W.	N. 70° W.	270	35·47	15·11			
,, 8	N.W.	Various	35	At Malta.				(Date of arrival.)
				N.	E.			
Oct. 9	S.E.	Various	153	37·00	11·04	989	93·55	Moderate winds and weather throughout.
,, 10	N.W.	,,	284	37·31	6·59			
,, 11	Variable	S. 82° W.	251	36·55	1·40			
,, 12	,,	S. 85° W.	260	36·32	West			
,, 12	,,	Various	291	..	3·30			(Date of arrival.)

Date.	Winds.	Courses.	Distance. Miles.	Latitude.	Longitude.	Total. Miles.	Total. Hrs. M.	Remarks.
				N.	W.	1812	171·25	.. Brought forward.
Oct. 13	E.	Various	135	36·37	7·54			Light winds and fine.
,, 14	N.	,,	210	39·32	9·46			Strong head winds at sea.
,, 15	N.E.	N. 5° W.	138	42·25	10·03	1170	127.55	Strong head gale and sea.
,, 16	,,	Various	209	44·57	8·12			Same weather.
,, 17	E.	N. 32° E.	252	48·35	5·10			Light winds.
,, 18	Calm	Various	226	..	..			(Date of arrival.)
						2982	299.20	

Or at the average rate of about 10 knots an hour.

Sailed from Alexandria, October 5th, 10.25 a.m.
Arrived at Malta . . . „ 8th, 3.55 p.m.
„ Gibraltar . . „ 12th, 8.8 p.m.
„ Southampton . „ 18th, 7.45 a.m.

Abstract of Log of the P. & O. Company's Ship "Khedive," on her Voyage from Southampton to Alexandria.—October, 1873.

Date.	Winds.	Courses.	Distance. Miles.	Latitude.	Longitude.	Total. Miles.	Total. Hrs. M.	Remarks.
				N.	W.			
Oct. 31	S.W.	Various	210	48·44	5·22			Left Southampton at 3 p.m. Oct. 30.
Nov. 1	W.	S. 17° W.	233	45·01	7·02			Moderate gale—squalls.
,, 2	N.W.	Various	240	41·59	9·59	1174	111.45	Strong breeze and fine.
,, 3	,,	S. 7½° E.	273	37·30	9·10			Moderate and fine.
,, 4	,,	Various	218	..	..			Arrived at Gibraltar at 7 a.m.
				N.	W. / E.			
Nov. 4	Wly.	Various	17	36·09	E.			Left Gibraltar at 10 A.M.
,, 5	,,	N. 81½° W.	294	36·52	0·53			Fresh breeze and fine.
,, 6	S.-Wly.	N. 82° E.	293	37·32	7·04	987¾	83.45	ditto. ditto.
,, 7	Sothly.	Various	276	36·44	12·38			Light ditto.
,, 8	,,	,,	107¾	..	..			Arrived at Malta at 9.45 p.m.
				N.	E.			
Nov. 8	S.W.	Various	46	35·44	15·22			Left Malta at 7.10 A.M.
,, 9	E.N.E.	S. 72° E.	255	34·26	20·23	825½	75.50	Moderate breeze and fine.
,, 10	Calm	S. 68° E.	267	32·46	25·20			Calm and fine.
,, 11	E.	Various	257½	..	..			Arrived at Alexandria at 11 a.m.
						2987¼	271.20	

Or at the average rate of about 11 knots an hour.

APPENDIX No. 23. Vol. iv., 394.

***Fleet of the Peninsular and Oriental Steam Navigation Company, with Particulars of their Employment, January* 1875.**

No.	Names of Vessels.	Tonnage.	Horse Power Nominal.	Remarks.
1	Australia	3,663	600	
2	Avoca	1,482	250	
3	Bangalore	2,063	500	
4	Baroda	1,874	400	
5	Bokhara	2,932	450	
6	Cathay	2,982	450	
7	Delhi	2,178	400	
8	Geelong	1,834	250	
9	Golconda	1,909	450	
10	Gwalior	2,725	450	
11	Hindostan	3,113	600	
12	Hydaspes	2,984	450	
13	Indus	3,470	500	
14	Kashgar	2,621	450	
15	Khedive	3,742	600	
16	Khiva	2,609	450	
17	Lombardy	2,723	450	Mediterranean, Adriatic, India, and China Services.
18	Malta	1,942	500	
19	Malwa	2,933	450	
20	Mirzapore	3,763	600	
21	Mongolia	2,833	530	
22	Mooltan	2,257	450	
23	Nizam	2,725	450	
24	Pekin	3,777	600	
25	Peshawur	3,781	600	
26	Simla	2,441	630	
27	Sumatra	2,488	450	
28	Surat	3,141	530	
29	Tanjore	2,245	400	
30	Teheran	2,589	400	
31	Thibet	2,593	400	
32	Travancore	1,900	400	
33	Venetia	2,726	450	
34	Zambesi	2,431	370	
35	Ceylon	2,111	450	
36	Nubia	2,096	450	
37	Pera	2,119	450	Australian Service.
38	Ellora (between Melbourne and Sydney.)	1,727	300	
39	Behar	1,723	300	
40	Bombay	1,327	275	
41	Malacca	1,709	300	China and Japan local Service.
42	Massilia	1,640	400	
43	Orissa	1,647	300	
	Carried forward	107,568	19,135	

Fleet of the Peninsular and Oriental Steam Navigation Company, with Particulars of their Employment, January 1875.—*Continued.*

No.	Names of Vessels.	Tonnage.	Horse Power Nominal.	Remarks.
	Brought forward .	107,568	19,135	
44	Adria	1,225	110	Cargo Vessels.
45	Columbian	2,283	500	Cargo Vessels.
46	Sunda	1,682	300	Under alterations and re-fitting.
47	Poonah	2,152	600	Under alterations and re-fitting.
48	Deccan	3,128	600	Under alterations and re-fitting.
49	China	2,010	400	Under alterations and re-fitting.
50	Candia	1,982	450	Laid-up.
		122,030	22,095	

STEAM-TUGS.

No.	Names of Vessels.	Tonnage.	Horse Power Nominal.	Remarks.
51	Ansari	146	40	Egypt.
52	Gabari	34	20	Egypt.
53	Timsah	271	120	Egypt.
54	Pauline	20	14	Egypt.
55	Sirsar	55	30	Aden.
56	Parell	24	12	Bombay.
57	Colaba	145	60	Bombay.
58	Howrah	70	25	Bombay.
59	Bandora	128	20	Bombay.
60	Sewree	128	20	Bombay.
61	Säada	99	60	Hong Kong.
62	Dragon	89	24	Shanghai.
63	Stork	31	15	Yokohama.
		1,240	460	

CARGO AND COAL HULKS.

No.	Names of Vessels.	Tonnage.	Horse Power Nominal.	Remarks.
64	Fort William	1,800	. . .	Hong Kong.
65	Larkins	1,000	. . .	King George's Sound.
66	Tiptree	1,617	. . .	Yokohama.
		4,417		

APPENDIX No. 24. Vol. iv., p. 425.

Fleet of the Messageries Maritimes Company, January 1875.

India, China, Japan, Batavia, and Mauritius Lines.

		Gross Tonnage. English.	H. P. Nominal.			Gross Tonnage. English.	H. P. Nominal.
Anadyr .	. screw	3671	600	Sindh .	. screw	3005	500
Iraouaddy .	,,	3471	600	Amozone .	,,	3005	500
Hooghly . .	,,	2820	500	Meinan . .	,,	1380	280
Tigre . . .	,,	3017	500	Menzaleh .	,,	1592	280
Provence . .	,,	2524	500	Tanaïs . .	,,	1584	280
Donnaï . . .	,,	2524	500	Dupleix .	,,	1380	280
Peï-ho . . .	,,	3050	500	Volga . .	,,	1502	280
Ava	,,	3050	500	Godavery .	,,	1423	280
Meikong . .	,,	3050	500	Newa . .	,,	1035	370

River Plate and Brazil Lines.

		Gross Tonnage.	H. P.			Gross Tonnage.	H. P.
Niger .	. screw	3417	600	Rio Grande .	screw	2739	500
Sénégal . .	,,	3417	600	Mendoza .	,,	2735	500
Gironde . .	,,	2981	500	Érymanthe .	,,	2015	400

Mediterranean and Black Sea Lines.

		Gross Tonnage.	H. P.			Gross Tonnage.	H. P.
Cambodge	. screw	2524	500	Hermus .	. screw	778	240
Amérique .	,,	1697	450	Ilissus . .	,,	1587	240
Péluse . .	,,	1750	400	Simoïs . .	,,	970	240
Mœris . . .	,,	1750	400	Mersey . .	,,	886	240
Saïd	,,	1750	400	Emirne . .	,,	1000	240
Alphée . . .	,,	1725	400	Mozambique	,,	1000	240
Cydnus . . .	,,	1196	370	Tamise . .	,,	729	200
Danube . . .	,,	1186	370	Clyde . .	,,	749	200
Phase . . .	,,	1200	370	Copernic .	,,	1217	200
Scamandre .	,,	1761	300	Cheliff . .	,,	992	180
La Bourdonnais	,,	1632	280	Delta . .	,,	932	150
Niémen . .	,,	1584	280	Sinaï .	paddle	888	370
Tibre . . .	,,	1729	280	Carmel . .	,,	958	370
Eridan . .	,,	1584	280	Aunis . .	,,	1025	250
Tage	,,	1691	280	Saintonge .	,,	1025	250
Èbre	,,	1701	280	Balkan . .	,,	430	160
Aréthuse . .	,,	1121	250	Taurus . .	,,	497	160
Méandre . .	,,	969	500				

London and Marseilles Line.

	Gross Tonnage.		H. P.
Euphrate	1507	..	250 compound.
Indus	1523	..	250 do.
Gange	1446	..	250 do.

Building.

	Gross Tonnage.	H. P.		Gross Tonnage.	H. P.
Djemnah . . screw	4000	600	Equateur . screw	4000	600
Orenoque . ,,	4000	600	* * * . ,,	4000	600

APPENDIX No. 25. Vol. iv., p. 444.

Statement of the Number of Vessels, with their Tonnage, that have passed through the Suez Canal.

Nationalities.	Year 1870.		Year 1871.		Year 1872.		Year 1873.		Year 1874.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.	Number.	Tons.	Number.	Tons.
Great Britain	314	289,234	502	546,453	761	1,059,926	813	1,499,791	898	1,797,494
France	75	84,657	66	89,076	80	162,621	83	221,810	87	222,945
Austria	26	19,382	63	38,728	61	53,066	70	90,967	61	84,159
Italy	10	5,795	47	27,413	66	48,001	58	59,121	52	63,498
Holland	2	313	5	6,714	13	26,420	36	72,592	53	106,422
Turkey	17	10,996	32	18,229	33	32,697	26	20,116	15	13,792
Germany	..	..	7	2,069	16	12,181	28	35,619	31	39,841
Spain	3	732	5	3,158	8	7,769	17	31,299	27	50,417
Russia	1	480	5	4,820	10	13,134	9	14,361	7	11,977
Egypt	33	22,053	22	13,334	13	7,919	7	6,246	8	6,461
Denmark	1	660	1	660	1	570	5	6,438	1	1,094
Norway	..	..	1	1,316	6	4,000	5	9,298	8	13,489
Sweden	..	..	..	..	1	532	4	4,304	6	6,559
Belgium	..	..	4	4,400	..	..	4	6,911	1	908
Portugal	1	371	2	920	10	8,366	2	753	3	2,618
Japan	..	..	..	..	..	..	2	1,004	1	1,010
United States	1	306	3	4,171	2	1,245	1	2,211	..	..
Burmah	..	..	..	..	..	..	1	677	..	..
Greece	1	48	..	..	..	..	1	208	5	984
Peru	..	..	..	..	..	..	1	1,299	..	..
Zanzibar	1	881	..	..	..	..	..	..	..	..
Tunis	..	..	..	..	1	726	..	..	..	..
Totals	486	435,908	765	761,461	1,082	1,439,167	1173	2,085,065	1,264	2,423,668

APPENDIX No. 26. Vol. iv., p. 554.

Average Time of Passages of the Four Mail Packets between Kingstown and Holyhead (Distance 56 *Knots, or* 65¼ *Statute Miles), for* 14 *Years, ending* 30*th September*, 1874.

	Ulster.		Munster.		Leinster.		Connaught.		Four Packets.	
	Trips	Time H. M.	Trips	Time H. M.	Trips	Time H. M.	Trips	Time H. M.	Trips	Time H. M.
Winter Half Years . .	2631	4 1·6	2240	3 59·1	2387	3 57·6	2939	3 56·0	10,197	3 58·5
Summer Half Years. .	2379	3 56·0	2667	3 52·8	2719	3 53·0	2478	3 52·2	10,243	3 53·7
Whole Years. . .	5010	3 58·9	4907	3 55·6	5106	3 55·1	5417	3 54·3	20,440	3 56·1

Note.—When two of the vessels, the *Leinster* and the *Ulster*, were completed and ready for duty, it was thought advisable to make a trial with them, by way of practice, in the performance of the old contract. Each performed the distance between the lighthouse on Kingston Pier to the lighthouse at Holyhead, upwards of 65¼ statute miles, in nearly the same time on the average, namely, the *Leinster*, in three hours and thirty-one minutes, and the *Ulster* in three hours and thirty-two minutes, being respectively thirteen and twelve minutes less than the shortest monthly average of the *Banshee* in 1848–49, and twenty and nineteen minutes less than the *Llewellyn*, when the distance between the lights was one mile less than in 1860—the Holyhead breakwater not having been then in existence. The gain in speed realized by the new vessels was therefore at the rate of from 1·2 to 1·7 mile per hour.

The shortest passage of the *Leinster* was made in three hours and twenty minutes; that of the *Ulster* in three hours and eighteen minutes, and of the *Munster* in three hours and twenty-six minutes. But the average performance of the vessels for the first two years and five months during which they had been on service was still closer. Inclusive of all passages made in fogs, gales, &c.,

			H. M.
The *Connaught* made	1,064	passages in the average time of	3 51·5
The *Leinster* . .	919	„ „	3 52·5
The *Ulster* . .	925	„ „	3 55
And the *Munster* .	920	„ „	3 58·1

So close a performance by four vessels, not identical and not all from the same builders and engineers, could scarcely have been anticipated. The longest passage made in the severest gales had to that time not exceeded five hours and forty minutes, and one vessel only had been that length of time on but two occasions.

Nearly 4000 passages have been already made without collision, except on one occasion, which happily was not attended with very serious consequences. Experienced naval officers anticipated frequent and serious disasters, but the rate of speed, 16 miles an hour, though high for night-work, does not appear to have been too high for safety. The sense of greater responsibility, and the larger number of men engaged in the navigation and management of the vessels, must naturally induce additional precaution, as well as afford the means of guarding against danger. The facility with which these large vessels are handled and brought alongside the jetties is remarkable. The practised skill of the officers, and the quickness with which the engines are managed, frequently succeed in getting the vessels alongside,

in making them fast, establishing the means of communication with the shore, and in landing the mails, in three or four minutes.

The consumption of coal in the first few months was considerably in excess of the quantity originally estimated. Steam of from 25 lbs. to 28 lbs. pressure was then used, which not only required much extra coal, but severely taxed the durability of the boilers. Arrangements were therefore made to reduce the consumption to the amount stated in the estimates submitted to Government, on which the contract was founded. The result has been satisfactory, while the additional time occupied on the passages is but a few minutes, and they are still made on the average within the time allocated to the sea service by the proposal of Government.

APPENDIX No. 27. Vol. iv., p. 583.

Number and Tonnage of Iron Steam Vessels built and first registered in the United Kingdom in each Year, from 1861 *to* 1874.

Years.	Number.	Tonnage.
1861	159	68,368
1862	181	76,303
1863	240	105,837
1864	342	156,981
1865	344	177,382
1866	299	129,653
1867	224	90,823
1868	188	75,109
1869	238	118,421
1870	382	222,922
1871*	416	295,109
1872*	446	335,750
1873*	335	279,088
1874*	393	328,094

* Number and tonnage of vessels of which the building was completed within the year.

Total Tonnage (distinguishing sailing and steam) belonging to the United Kingdom, British Possessions, United States, France, Holland and Norway, in each of the Years 1850, 1860, 1870, 1871, 1872, 1873 *and* 1874 (*so far as the same can be given*).

	Years.	British Empire.		United States.		France.	Holland.	Norway.
		United Kingdom.	British Possessions.	Registered.	Enrolled and Licensed.			
		Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
SAILING.	1850	3,337,546	707,785	1,540,769	1,468,739	690,111	393,750	Not distinguished.
	1860	4,134,390	1,076,434	2,448,941	2,036,990	915,971	543,320	
	1870	4,506,318	1,440,682	1,324,256	1,795,389	917,633	474,463	1,008,800
	1871	4,305,112	1,425,976	1,244,228	1,898,551	917,133	458,274	1,042,259
	1872	4,145,888	1,427,302	1,232,982	2,037,422	911,613	449,717	1,090,006
	1873	4,024,581	1,443,911	1,229,865	2,252,895	882,866	438,031	1,205,998
	1874	4,043,955	1,502,302	..	..	..	440,879	..
STEAM.	1850	167,398	20,233	44,942	481,004	13,925	3,672	Not distinguished.
	1860	452,352	47,792	97,296	770,641	68,025	12,990	
	1870	1,111,375	90,759	192,544	882,551	154,415	24,942	13,715
	1871	1,317,548	94,255	180,914	906,723	160,478	34,629	20,015
	1872	1,536,075	104,564	177,666	933,887	177,462	43,820	30,382
	1873	1,711,787	113,951	193,423	963,020	185,165	57,254	39,295
	1874	1,868,359	118,876	..	..	..	71,101	..
TOTAL.	1850	3,504,944	728,018	1,585,711	1,949,743	704,036	397,422	281,377
	1860	4,586,742	1,124,226	2,546,237	2,807,631	983,996	556,310	558,928
	1870	5,617,693	1,531,441	1,516,800	2,677,940	1,072,048	499,405	1,022,515
	1871	5,622,660	1,520,231	1,425,142	2,805,274	1,077,611	492,903	1,062,274
	1872	5,681,963	1,531,866	1,410,648	2,971,309	1,089,075	493,537	1,120,388
	1873	5,736,368	1,557,862	1,423,288	3,215,915	1,068,031	495,285	1,245,293
	1874	5,912,314	1,621,178	..	..	..	511,980	..

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END OF VOL. IV.

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